(NASA-CR-159547) THE 18/30 GHz FIXED COMMUNICATIONS SYSTEM SERVICE DEMAND ASSESSMENT. VOLUME 2: MAIN TEXT (Western Union Telegraph Co.) 328 p HC A15/MF A01 CSCL 17B G3/32

N80-22548

Unclas 47363

NASA CR-159547

western union

18/30 GHz FIXED COMMUNICATIONS SYSTEM SERVICE DEMAND ASSESSMENT

BY T. GABRISZESKI, P. REINER, J. ROGERS AND W. TERBO
WESTERN UNION TELEGRAPH COMPANY

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASA LEWIS RESEARCH CENTER
NAS-3-21359

VOLUME II — RESULTS

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CR 159547 Vol. II, Main Text		

4. Title and Subtitle
18/30 GHz FIXED COMMUNICATIONS SYSTEM SERVICE DEMAND ASSESSMENT

5. Report Date
July , 1979

6. Performing Organization Code

7. Author(s)
T. Gabriszeski, P. Reiner, J. Rogers, W. Terbo

8. Performing Organization Report No.

10. Work Unit No.

9. Performing Organization Name and Address
Western Union Telegraph Company
1 Lake Street
Upper Saddle River, New Jersey 07458

11. Contract or Grant No.
NAS-3- 21359

13. Type of Report and Period Covered
Contractor Report

12. Sponsoring Agency Name and Address
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135

14. Sponsoring Agency Code

15. Supplementary Notes
Project Manager, Steven M. Stevenson
Communications and Applications Division

16. Abstract
This study forecasts the total demand for communications services, and satellite transmission services at the 4/6 GHz,12/14 GHz and 18/30 GHz frequencies. The services are voice, video and data services. Traffic demand, by service, is distributed by geographical regions, population density and distance between serving points. Further distribution of traffic is made among four major end user groups: Business, Government, Institutions and private individuals. A traffic demand analysis is performed on a typical metropolitan city to examine service distribution trends. The projected cost of C and Ku band satellite systems are compared on an individual service basis to projected terrestrial rates. Separation of traffic between transmission systems, including 1 '30 GHz systems, is based on cost, user, and technical considerations.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Communications Services, Baseline Forecast, Market Determinant Factors, Parametric Cost Model, Net Addressable Market, Trunking Earth Stations.	Unclassified

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	310	

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-C-168 (Rev. 10-75)

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF FIGURES

LIST OF FIGURES (cont'd)

LIST OF FIGURES (cont'd)

LIST OF TABLES

LIST OF TABLES

(cont.)

LIST OF TABLES

(cont.)

LIST OF TABLES

(cont.)

LIST OF TABLES

(cont.)

LIST OF TABLES

(cont.)

INTRODUCTION AND SUMMARY

1.0 INTRODUCTION

1.A OBJECTIVES

The "18/30 GHz Fixed Communications Satellite Systems Service Demand Assessment for 1980-2000" (the study) was performed by Western Union in support of NASA's efforts to define an economically viable 18/30 GHz communications satellite system which can provide high capacity services in a spectrum conservative fashion. As part of these studies, Western Union has focused its marketing efforts on forecasting the total domestic demand for long haul telecommunications services.

There are essentially seven major objectives or tasks of the study:

1. Project telecommunications services traffic volumes for the 1980-2000 period in three major classes of service
    - voice
    - video
    - data
2. Assess the relationship of traffic volume to:
    - mileage band distance distribution
    - population density
    - U.S. geographical distribution
    - price sensitivity
3. Identify service traffic volumes by major user category
    - business
    - institutions
    - government
    - private

4. Perform an analysis of traffic demand within a representative metropolitan area

5. Analyze the present and future satellite and terrestrial service costs

6. Evaluate the demand for communications services as a function of:

   - reliability

   - real vs. non-real time

7. Estimate the traffic volume for 18/30 GHz systems in the years 1990 and 2000.

The services are divided into three generic categories, each expressed in an application unit of traffic measure. The first category is voice services, expressed in half-voice circuits; the second is video services, displayed in numbers of wideband channels; a third generic category is data services projected in terabits (10^{12}) per year.

Beyond these three generic service categories, a further level of service detail exists which identifies specific communications applications, such as MTS and private line voice, etc.

1.B BACKGROUND

Due to the rapid growth in demand for telecommunications services, there is expected to be a continuous requirement for increased transmission system capacity and capabilities. An increasing portion of this traffic is being carried by domestic satellite systems. Satellite systems are rapidly filling the available orbital spectrum in 6/4 GHz (C-band) frequency, and carriers are planning systems in the early 1980's which will use 14/12 GHz (Ku-band).

Due to international allocations and technical constraints, and the continued growth in demand, there could be a saturation of both of these bands sometime within the next 10 to 20 years. The next available frequency for domestic satellite usage is the 18/30 GHz band. The large bandwidth available for use and new technological approaches can make the communications capacity of this band virtually unlimited.

In order to better understand the role 18/30 GHz systems may play in future satellite communications, NASA desires to know what services are economically viable in this frequency range. To accomplish this feasibility assessment, NASA has contracted with two common carriers, to perform market studies and two system contractors to perform system studies of 18/30 GHz satellite systems.

These studies are only the first phase of a three phase effort to assess the potential need, costs and design for 18/30 GHz satellite systems.

1.C CONSIDERATIONS

All costs employed in the development of the projected service cost models are in terms of 1978 dollars to remove the uncertainties of inflation. However, due to anticipated efficiencies in earth station technology and industry production costs, the cost models reflect a projected decline in satellite system costs over the 1980-2000 period. In addition, the satellite system cost model reflects a network of a representative size. The aggregate traffic demand supported by a satellite system can have an important impact on the representative service costs. The study has tried to consider the system fill factor along with other influencing factors such as the system capacity, mix of service traffic and regulatory environment. Some uncertainties in projected service costs must be recognized and accepted.

Projected satellite communications traffic is expressed as the net addressable market demand. This term means the total traffic which can be suitably served by the frequency band.

The level of potential market penetration (accessible market) is a function of the multiple common carriers vying for market share and other competitive aspects. Therefore, caution is advised in assuming that the projected 18/30 GHz net addressable demand represents the projected traffic carried on a single 18/30 GHz satellite system.

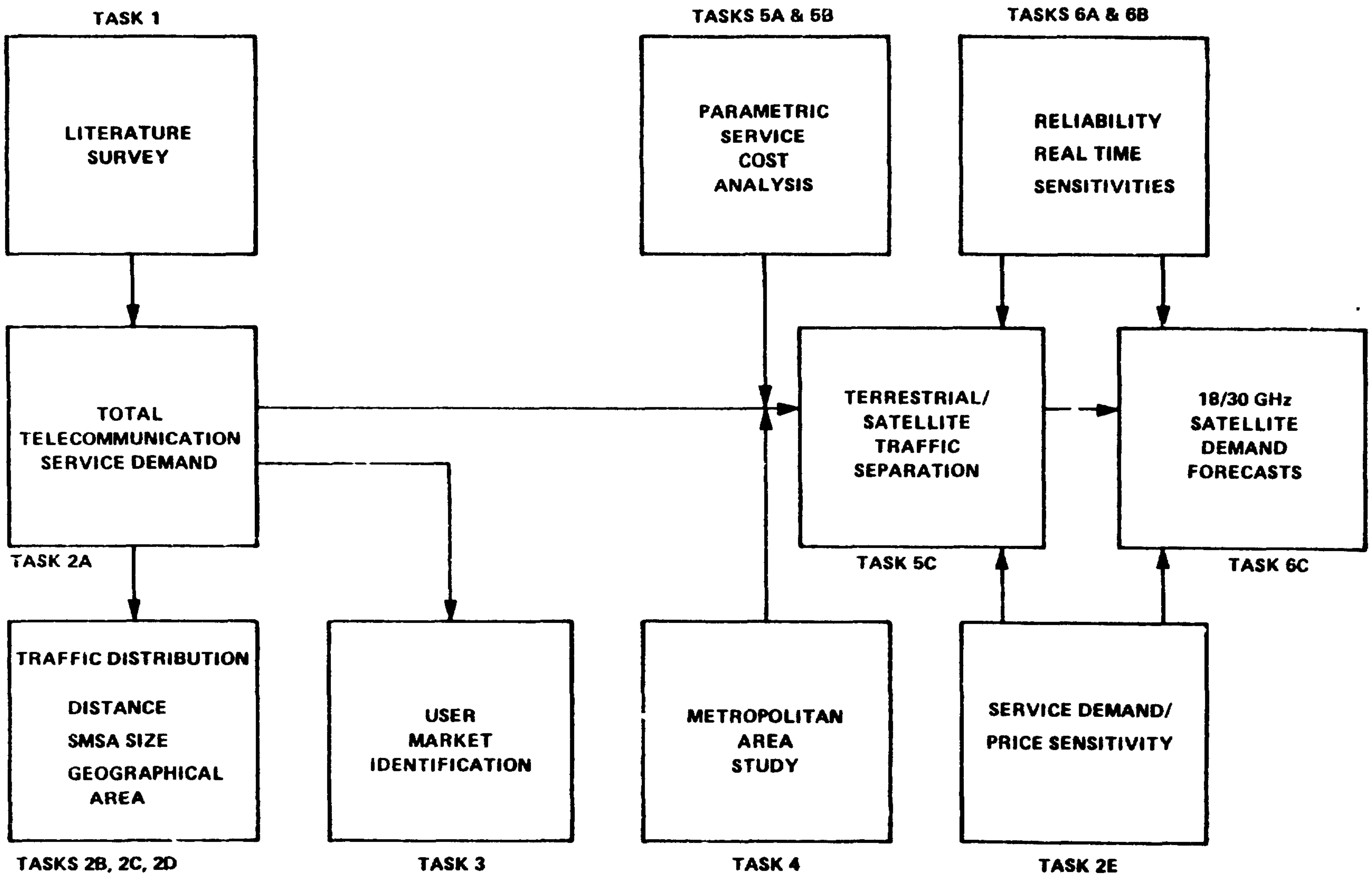
The difficulties in accurately determining changes in communication markets over a twenty year period should be recognized. Through such means as considering potential market determinant factors and cross impact modelling, Western Union has tried to account for the effect of various market environment uncertainties. However, changes in the timing and extent of impact of these factors plus other influencing factors which may not have been considered, could have some affect on the service traffic projection contained herein.

2.0 METHODOLOGY AND APPROACH

2.A METHODOLOGY

The starting point for the Study is a detailed review of all literature and material dealing with communications services, systems and technology. The objective of this task was to review previous market demand projections, assess market trends and identify specific voice, video and data service applications. A total of 31 separate communication applications were defined.

The market study consists of six major tasks, some of which contained several important subtasks. These study tasks were performed in an orderly, sequential manner in most cases, but some were parallel efforts whose results influenced the market study at a later point. The relationship and flow of the individual study tasks is shown in Figure 1.



STUDY TASK RELATIONSHIPS

FIGURE 1

2.B APPROACH

For each of the three services an examination was made of their current level of traffic demand, each expressed in the service's unit of measure. From this current level of demand three types of forecasts for the 1980-2000 period were made, each forecast more refined than the previous.

The baseline forecast of traffic is predicated on an orderly growth and lower risk of market events.

The impacted baseline traffic forecast is a modification of the baseline and reflects the effect of higher risk events through use of market determinant factors: socio/economic, technology, regulatory, competition and price elasticity. These events are combined in a probabilistic fashion resulting in a high, low and expected set of traffic forecasts. A computer program was developed to account for all the cross impacting relationships, assuring consistency among the forecasts and elimination of duplicate demand.

The net long haul traffic forecast is the product after eliminating traffic from several sources, namely: traffic which flowed within the same Standard Metropolitan Statistical Area (SMSA) (U.S. Department of Commerce), traffic of less than 40 miles in distance (local) and traffic flowing to and from the U.S. hinterland areas, that is, outside the 275 Standard Metropolitan Statistical Areas included in the study. This net long haul traffic represents the service demand used in all other traffic distribution tasks.

Satellite services traffic demand is segregated from total demand by the development of parametric satellite service cost models, determination of the crossover point for satellite and terrestrial service cost comparisons, and consideration of several specific user/usage and technical characteristics applied to each service application.

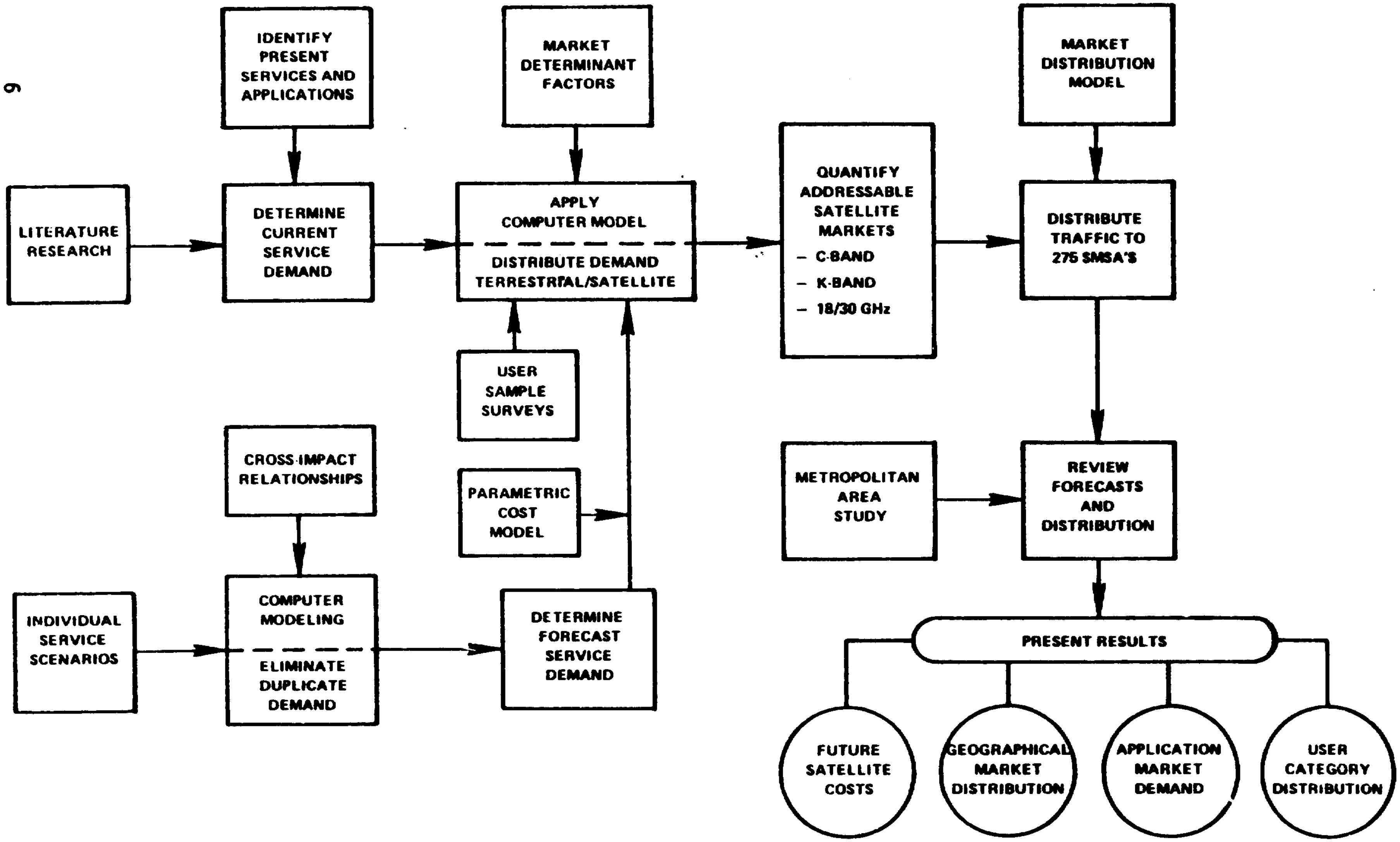
Further segregations of total satellite addressable market demand are made to separate net market demand for C-band, and Ku-band systems. A number of qualifying criteria such as service cost comparisons, operating characteristics, etc., are considered in these further separations.

The final segregation involves identification of net addressable 18/30 GHz satellite market. The refinement is a function of three system scenarios which define 18/30 GHz level of service quality and price in relation to Ku-band systems. Consideration is given to cost crossover criteria and trends established for C and Ku-band forecasts to yield the net addressable market demand for 18/30 GHz satellite systems.

A pictorial display of the entire market research methodology reflected above is shown in Figure 2.

2.C PRESENTATION OF RESULTS

The total net long haul telecommunication traffic forecast by service category is distributed according to several subtask requirements.



MARKET RESEARCH ACTIVITY FLOW

FIGURE 2

A distribution of traffic is made by U.S. geographical areas, by major user category, by SMSA size expressed in terms of population density, and by distance of circuit length. Another format for presentation is the projection of traffic by services/applications for 1980, 1990 and 2000.

The estimate of future cost profiles of projected terrestrial and satellite services is expressed as a function of distance. The service cost categories include voice, low speed, medium speed and high speed data services. Video was omitted because of its broadcast nature and the great variability in downlinks requirements. Projected satellite and terrestrial rates are compared to determine crossover distances and to indicate economic efficiencies for each service.

The projection of satellite services demand is expressed in two forms. First, for each service category (voice, video and data), the forecast is presented in half voice circuits, wideband video channels and terabits per year or megabits per second, respectively. Another presentation of satellite traffic results is given in equivalent transponders. The unit measure, equivalent transponders, provides a common unit to display the net addressable satellite market for all service categories during the three time periods.

3.0 OBSERVATIONS

3.A The demand for telecommunications services already exhibits a relatively high growth rate which is expected to continue over the next 20 years. The fastest growing communications service category is data, with a projected average annual growth rate of around 17%, followed by video services growth at a 5% rate and voice services growth at almost 10% per year.

The fastest growing application in the voice services category is Message Toll Service for business use. It will grow from about one quarter of the voice traffic in 1980 to almost 40% of the total by year 2000. Data transmission applications currently represent the largest category of data services, but electronic mail applications are projected to grow significantly by the end of the study period. Likewise, video conferencing services are starting from a small base within the video services category but are projected to grow to more than half the long haul traffic demand for video by year 2000.

3.B Concentration of communications services traffic is observed on the basis of distance distribution in the mileage band ranges of 150 to 2100 miles, representing more than 78% of the voice and data traffic.

By population density, concentration of almost 50% of the traffic is seen in areas containing 1.5 million or more people.

Geographical distribution of traffic reflects a high degree of correlation with both population density and business activity by regions. The Middle Atlantic (NY, NJ, PA), East North Central (MI, WI, IL, IND, OH) and South Atlantic (MD, DEL, WV, VA, NC, SC, GA, FA) regions contain in a combined area more than 50% of the voice and data services traffic of the entire U.S.

User group distribution of traffic indicates that the business category represents more than 50% of voice services, more than 75% of video services and more than 80% of data services. The government sector's usage levels range from only 7% of video services to a high of 16% of data services.

3.C Three levels of service reliability are defined: high (99.9 to 99.99%), medium (99.0 to 99.9%), and low (95.0 to 99.0%). Video services such as network TV require the highest level of reliability. Voice services such as private line require slightly less reliability. Data services, especially electronic mail, can tolerate more frequent outages.

As a function of service reliability, a close correlation exists between decreasing reliability and expected price reduction perceived by the users. However, at a certain reliability threshold, low reliability service will not be tolerated even if the price drops to zero.

Delayed delivery of certain communications is tolerated as expected price reduction accelerates, reaching a point where a 40-60% price break is expected for a one day delay in message delivery over real-time delivery.

3.D The rate of projected price decline of all satellite services as determined by the parametric cost model is a function of two factors:

- market demand expressed in terms of system fill levels
- introduction of new technologies such as use of the space shuttle and lower cost earth stations which will influence system costs

3.E A steadily increasing proportion of the total long haul traffic will be addressable by satellite. The forecasts indicate that in 1980, 19% of total traffic is addressable by satellite and that proportion will increase to about 25% by year 2000.

Over the twenty year period voice traffic will continue to dominate the market, with about 75% of total addressable satellite demand.

Video traffic will exhibit a high proportion of total long haul traffic addressable by satellite due to its broadcast nature and one-way applications.

Data traffic will also show a growing penetration by satellite systems, reaching 63% of total long haul demand by year 2000, due to expected technological and price improvements.

3.F The study results clearly identify a number of important considerations influencing both the system requirements and market demand.

Traffic distribution on a nationwide basis varies to a wide extent. New York City metropolitan area is the largest SMSA with about 10% of total traffic; the 20th largest SMSA, Miami, contains only 1.2% of total market demand. The variance in demand by geographic area at any one time indicates a need for flexible allocations of satellite capacity.

The cities or markets to be served via 18/30 GHz may be functions of the beam coverage capability for that area, the requirements for varying allocation of capacity and the concentration of traffic along heavy traffic routes.

A limitation which must also be considered is with the expression of traffic forecasts as "net addressable market" demand. That demand is the maximum amount of traffic that is suitable for implementation in the specific satellite systems scenario. Two limitations that arise from the definition are:

- This demand clearly over-represents the amount of traffic which would actually be placed on satellite systems.
- This demand represents a composite of all satellite systems - C and Ku-band and 18/30 GHz - which compete for the same market.

The difficulty in arriving at the traffic actually implemented on a specific satellite system relates to multiple carrier competition and the extent of individual carrier capture ratio. It is believed that the means to determine the potential system traffic requirements, which is invaluable in system sizing, is through the use of market scenarios which examine alternative network size and service price variations.

4.0 REPORT ORGANIZATION

This report is divided into three volumes in order to assist the reader in the task of assimilating all the data provided. Volume I is an executive summary giving major study objectives, an overview of the methodology, summary of results, general conclusions, and consideration of future follow on research efforts. Volume II contains the essence of the study with summaries of the analytical and detailed aspects included. Volume III is an appendix which contains details on research methodologies, interim calculations and a number of printouts from the computerized traffic runs.

Volume II is further divided into seven sections, the first covering this Introduction and Summary and the remaining six devoted to each of the major study tasks.

Section 1 - Literature Survey

Section 2 - Demand Forecasts for Telecommunication Services

Section 3 - User Market Identification

Section 4 - Metropolitan Area Study

Section 5 - Present and Projected C and Ku-band Satellite Service Costs

Section 6 - 18/30 GHz Communications Service Demand Forecasts

For each section of Volume II a similar report format has been adopted for ease in reading and structuring of information. Each of the sections contains the following six parts:

1. Statement of Work
2. Introduction
3. Methodology
4. Computer Modelling Efforts
5. Presentation of Results
6. Significant Conclusions.

SECTION 1

TASK 1 LITERATURE SURVEY

1.0 STATEMENT OF WORK

The Contractor shall conduct a comprehensive literature search of studies that have been performed concerning domestic communications demand projections. Items to be noted include the constituency, magnitude, and demographics of the user population, present and potential services, estimates of traffic volumes, growth trends, and geographical distributions of traffic demand. This information shall be critiqued and conclusions drawn concerning its current validity, assumptions made, methods of analysis, and consistency of results.

2.0 INTRODUCTION

2.A PURPOSE

The purpose of the literature survey was to create a store of information relative to market and technological influences and trends, in particular projections of demand, that would facilitate the work efforts of subsequent tasks. Of those documents which were available, it was necessary to evaluate each document, screening out those that were not germane or reliable.

2.B SCOPE

The scope of the literature survey was considerable, covering briefly: existing and potential voice, video and data services; projected and historical demand data for three service categories; satellite and terrestrial transmission media and various traffic distributions. See Table I-1 for more specific coverage. In total, 276 documents were reviewed, including 121 magazine articles, 53 consultant reports, 28 government reports, 13 in-house reports, and 9 common carrier submissions before the FCC. No document circulated after November, 1978, was formally included in the literature survey, although relevant source material discovered after that date was used, in some cases, in the preparation of the final report.

Table I-1. Scope Of Literature Survey

I. Services: Present and Potential

a) Voice
b) Video
c) Data

II. Demand Forecast

a) By service category
b) User constituency
c) Geographic distribution or representation of users

- to demand
- to reliability

e) Reliability considerations

III. Period Covered by Research - 1980 to 2000

a) Historical data for establishment of baseline 1977-78 position

IV. Transmission Media

a) Terrestrial

- Microwave
- Coaxial cable millimeter waveguide
- Fiber Optic Cable

b) Satellite

- C-Band
- Ku-Band
- 18/30 GHz

V. Service Applications

a) By industry category
b) By geographic region
c) Price relationships
d) Reliability considerations

2.C OVERVIEW

The literature survey was an essential component of the NASA Market Demand Study, involving 750 man-hours and over 250 documents. The latter were obtained from Western Union's library or, as was more frequently the case, from outside sources: industry consultants, library and research organizations, trade associations, and federal regulatory bodies and other governmental agencies. Information that was considered valuable and whose validity was confirmed was recorded on standardized forms or photocopied, thereby becoming a considerable store of information available to subsequent tasks. An annotated bibliography was also assembled, annotations generally setting forth the principal conclusions of the documents and noting any remarks made about 18/30 GHz transmission.

3.0 METHODOLOGY

The literature survey was the first task undertaken in the study. Each study participant was assigned one or more areas of interest (mobile radio communications, electronic funds transfer systems, etc.), which he then researched, collecting and reviewing all documents of reasonable applicability. The process of collection consisted of visiting public and private libraries, the latter including Western Union's own store of materials, and of writing to or telephoning other, less accessible or more specific information sources. Internally generated documents, those documents collected from Western Union's store of materials, included market research studies, market plans and forecasts, and technical papers. Externally generated documents, which made up the remaining documents collected, included material prepared by industry consultants, library and research organizations, trade associations, and federal regulatory bodies and other government agencies. (Tables I-2, I-3, I-4, I-5 and I-6 are more specific lists of sources)

Information that was considered valuable was recorded on standardized forms (Figure I-1 is illustrative) or, as was often the case, photocopied (see Figure I-2). Collected in this manner, it was then available to succeeding tasks. For example, information provided in Figures I-1 and I-2 was used to forecast demand for satellite delivery of video programming to the CATV community (Task 2.A), to identify factors that would, under extraordinary circumstances, affect baseline demand (also Task 2.A), and to assign such demand to "effective" end users (Task 3.A).

The finished product of the literature survey consisted of two volumes: the many pages of handwritten and photocopied data discussed above and an annotated bibliography of the 276 documents reviewed, which can be found in the Appendix. The annotations generally set forth the principal conclusions of the documents; they also noted any remarks made about 18/30 GHz transmission.

Table I-2 Literature Survey - Consultant Sources

Arthur D. Little	Cambridge, MA
Creative Strategies	San Jose, CA
Dataquest	Menlo Park, CA
Frost & Sullivan	New York, NY
Future Systems, Inc.	Gaithersburg, MD
GMS Consultants	Westport, CT
Horizon House International	Dedham, MA
INPUT	Menlo Park, CA
Intec, Inc.	Chicago, IL
International Data Corporation	Waltham, MA
International Resource Development, Inc.	New Canaan, CT
Linda Fenner Zimmer Associates	Park Ridge, NJ
Link	New York, NY
Network Analysis Corporation	Great Neck, NY
Systems Applications, Inc.	San Rafael, CA
Quantum Sciences	New York, NY
Yankee Group	Cambridge, MA

Table I-3 Literature Survey - Libraries & Research Organizations

Batelle Columbus Laboratories	Columbus, OH
Boston University and the Institute for Advanced Studies	Boston, MA
Dun & Bradstreet	New York, NY
IEEE Library	New York, NY
Institute for the Future	Menlo Park, CA
Jet Propulsion Laboratory	Pasadena, CA
Library of Congress	Washington, DC
London Communications Study Group	London, England
New York Public Library - Main Branch	New York, NY
New York Public Library - Lincoln Center	New York, NY
Rand Corporation	Santa Monica, CA
Rand McNally & Co.	New York, NY
Stanford Research Institute, Inc.	Menlo Park, CA
Television Digest, Inc.	Washington, DC
The Conference Board	New York, NY
University of Dayton Research Institute	Dayton, OH
Western Union Library	Upper Saddle River,NJ
Young & Rubicam	New York, NY

Table I-4 Literature Survey - Trade Associations

American Bankers Associations	Washington, DC
American Hospital Association	Chicago, IL
American Medical Association	Chicago, IL
Hospital Financial Management Association	Chicago, IL
International Communications Association	Mundelein, IL
National Association of Educational Buyers	Westbury, NY
National Automated Clearing House Association	Washington, DC
National American Telephone Association	Washington, DC
Public Service Satellite Consortium	San Diego, CA
The National Association of Business and Educational Radio	Washington, DC
The Telocator Network of America	Washington, DC

Table I-5 Literature Survey - Government Agencies
Department of Commerce - Bureau of Economic Analysis
Department of Commerce - Bureau of the Census
Department of Commerce - Office of Telecommunications
Executive Office of the President - Office of Management and Budget
Federal Communications Commission
General Services Administration
General Accounting Office
House Committee on Government Information
National Aeronautics and Space Administration
National Center for Educational Statistics
National Commission on EFT
National Technical Information Service
National Telecommunications Information Administration

Table I-6 Literature Survey - Journals and Newspapers

Astronautics and Aeronautics	Mini-Micro Systems
Aviation Week & Space Technology	Modern Data
Banking	Newsweek
Bell Laboratories Record	Quest (quarterly journal of TRW Defense Space Systems Group)
Bell System Technical Journal	
Broadcasting	Satellite Communications
Broadcast Management/Engineering	Scientific American
Business Communications Review	Spectrum
Business Week	Telecommunications
Communications News	
Computer Decisions	Telephony
Comsat Technical Review	Television/Radio Age
Data Communications News	The Media Report
Data Management	The New York Times
Datamation	The Wall Street Journal
Electronic News	The Washington Post
EMMS	Word Processing World
Electronics	
Harvard Business Review	
IEEE Communications Society Magazine	
Infosystems	
Microwave Journal	

NASA 18 - 30 GHz Market Research Study

Literature Survey

Subject: Video CATV

Reference: Southern Satellite's Taylor: "It's Rolling Like Gang Busters"

Title:

Author: Staff Report

Publisher: The Media Report, p.2

Date: 7/31/78

Information: (Attach copy of reproduction of site source page)

- Results of a survey conducted by Southern Satellite on future of satellite services delivered to the cable TV community.

- Fastest growth in pay TV.

- By the first of January 1979, at least 750 cable TV systems are expected to have working satellite earth stations (450 in place midway through 1978).

- Next four years on the satellite:

  1978 - 15 channels

  1980 - 31 channels

  1982 - 46 channels

  (breakdown attached)

Figure I-1

MR

Southern Satellite's Taylor: "It's Rolling Like Gang Busters"

By the year 1982 there could be as many as 46 programming services available to cable television companies and their subscribers via satellite, according to Ed Taylor, president of Southern Satellite Systems. Taylor released the results of a study his company recently conducted on the future of satellite delivered services at the July 19 meeting of the Community Antenna Television Association in Lake Eufaula, Oklahoma. A copy of the report was provided to MR. Taylor predicts the fastest growth will occur in pay-television. At present there are three satellite pay services in operation: HBO, Showtime and Fanfare. Home Theater Network is expected to start up in September and Holiday Inns and Americom Satellite Network hope to begin programming within the next several months. If SSS is correct, the number of pay channels will jump to 14 during the next four years.

. . . Taylor, whose Tulsa-based satellite common carrier delivers Atlanta's Channel 17 to over two million cable homes, looks for another six independent(non-network) television stations to be on the bird by 1982. SSS plans to offer KTVU, Channel 2, Oakland to cable systems by fall and possibly WGN, Chicago sometime next year. (Another company is also vying for the latter.) Other stations considered likely prospects for satellite transmission include New York's WPIX and WOR and L.A.'s KTTV and KTLA. Taylor feels the magic number of independents will be seven because "at that point all the programming available will be carried."

. . . Currently there are three religious channels on the satellite (Christian Broadcasting Network, Virginia Beach, Virginia; Praise The Lord Network, Charlotte, North Carolina; and Trinity Broadcasting Network, Orange County, California). We understand the Oral Roberts organization has the matter under consideration. In addition, the Catholic and Jewish religions have expressed some interest in developing a television network.

. . . By the first of next year it is expected that at least 750 cable television systems will have a satellite earth station in operation. (Applications for that number have already been filed at the FCC and 450 are in place today.) Taylor estimates the number of cable homes reached at that time will be five million, or approximately 15 million people. "I think it's going to keep right on going" he told MR, "maybe another 750. It's rolling like gang busters."

The Next Four Years On The Satellite
A Survey Conducted by
Southern Satellite Systems

Channels Today	Channels in 2 Years	Channels in 4 Years
3 Religious	4 Religious	6 Religious
1 Sports (Madison Square Garden)	2 Sports	3 Sports
6 Pay TV	12 Pay TV	14 Pay TV
3 Independents	5 Independents	7 Independents
1 Speciality	4 Speciality	5 Speciality
1 C-SPAN* (Cable Satellite Public Affairs Network)	1 C-SPAN	1 C-SPAN
	1 World of Business**	1 World of Business
	1 Spanish	1 Spanish
	1 Black	1 Black
		1 Ethnic
Slo-Scan (Transmission of audio and still pictures only)		
1 Newstime***	2 News programs	3 News programs
	2 Magazines	8 Magazines
15	31	46

ORIGINAL PAGE IS OF POOR QUALITY

* Will deliver the "live" telecasts of the U.S. House of Representatives

** A channel of business news, probably to be offered during the day. Could come from Channel 33 in Dallas, a new station scheduled to begin operation shortly.

*** A service of United Press International which started programming July 3.

FIGURE I-2

4.0 SOURCE VALIDATION

The validity of each document reviewed was determined by one or more of several means. Where a document was the only source of information on a particular subject, the degree of internal consistency and the reputation of the author were the principal checks of validity. Where a document was one of several sources of information on a particular subject, comparison of findings was an additional means of validation, serious departure of one set of findings from the other(s) indicating the presence of significant error. In the second case, availability of more than one source of information, findings that were in substantial agreement were often assembled into composited summaries.

5.0 TASK FULFILLMENT

The purpose of this task was to create a store of information that would facilitate the work efforts of subsequent tasks. To this end, the findings of documents that were considered valuable and whose validity was confirmed were recorded by various means. Not all documents that were reviewed were considered useful; some, upon inspection, were found to be unrelated to the study effort or out-of-date. Listed below are just a few illustrations of documents that were considered useful and were therefore made available for succeeding tasks:

(i) Frost & Sullivan's May 1978 market study, the U.S. Mobile Radio Equipment Market, which provided historical and prospective estimations of mobile radio equipment populations, data applicable to Task 2.A;

(ii) The Media Report's July 31, 1978 article, "Southern Satellite's Taylor: It's Rolling Like Gang Busters", which provided estimates of prospective demand for satellite delivery of video programming to the CATV community, data applicable to Tasks 2.A and 3.A;

(iii) Quantum Science Corp.'s 1977 market study, Data Base and Industry Sector Forecasts, an industry-by-industry summary of projected communications expenditures - broken down into equipment, leased facility, and labor subcategories - through the year 1980, data applicable to Tasks 3.A and 3.B;

(iv) The Bureau of the Census' 1976 and 1977 Statistical Abstract of the United States, which provided various statistical distributions by end user and geographical area, data applicable, in particular, to Task 3.C;

(v) The Phoenix Newspapers, Inc.'s Inside Phoenix 1978, which provided demographic and economic statistics concerning the Phoenix metropolitan area, data applicable to Task 4;

(vi) The Phoenix Metropolitan Chamber of Commerce's 1978 Arizona Directory of Manufacturers, useful to the process of selecting interview candidates in the Phoenix metropolitan area, also a part of Task 4; and

(vii) Future System Inc.'s commissioned report, Satellite Transmission Considerations in Support of 18/30 GHz Service Demand Study, which provided estimates of typical C- and Ku-band space and ground segment costs, data applicable to Task 5.

There were other documents that were of considerable value to the study effort. A complete list of relevant documents can be found in Section A of the Appendix.

SECTION 2

TASK 2 DEMAND FORECASTS FOR TELECOMMUNICATION SERVICES FOR THE PERIOD 1980-2000

1.0 STATEMENT OF WORK

Western Union will define the size and character of the long haul telecommunications market through the year 2000. The task requires quantification of the traffic volumes and growth rates for each of three service categories for the years 1980, 1990 and 2000, a distribution of market demand by transmission distance, the relationship of SMSA size to traffic volume and a projection of the relative concentrations of market demand in various graphical areas making up the 48 contiguous United States. The task also requires a sensitivity analysis comparing service demand to variations in service prices.

2.0 INTRODUCTION

Task 2 is divided in five subtasks identified as follows:

Task 2.A Telecommunications Service Demand

Task 2.B Distance Distribution of Traffic

Task 2.C Traffic Volume as a Function of SMSA Size

Task 2.D Geographical Distribution of Traffic Volumes

Task 2.E Sensitivity of Service Demand to Variations in Service Price

Each subtask will be analyzed and discussed separately. The methodologies and objectives of each subtask vary considerably. Task 2.A represents the foundation of the study forecasting and establishes the total long haul market demand for the data, voice and video service categories. Subsequent subtasks segregate the potential satellite traffic from the total (Task 5.C) and the potential 18/30 GHz satellite traffic from the satellite total (Task 6.C). Tasks 2.B, 2.C and 2.D establish further definition of the long haul market demand using the forecasts generated in Task 2.A. Task 2.E provides an insight into the potential effect on market demand caused by significant changes in service prices. This subtask is related to other analyses of demand sensitivity such as changes in service availability and real time transmission of traffic (Task 6.B).

Task 2 uses the product of Task 1, Literature Survey, plus extensive market research and analysis combined with computer modelling to provide the required forecasts and distributions. The net long haul traffic forecasts also provide the market demand distributed by user category in Task 3.

TASK 2.A TELECOMMUNICATION SERVICE DEMAND

1.0 STATEMENT OF WORK

Western Union shall prepare forecasts of telecommunication services traffic volume for the period 1980-2000 based upon the present day costs of satellite services. These services shall be categorized as: voice, video or data and estimates shall be made of the traffic volume and rate of growth for each category for the years 1980, 1990 and 2000. Traffic volume shall be quoted in terms of bits/year, equivalent half voice circuits, or equivalent wide band channels, as appropriate.

2.0 INTRODUCTION

The forecasts for the three service categories, voice, video and data are discussed separately due to significant differences in the methods of acquiring baseline market demands and in converting them into net long haul traffic. The three basic steps in generating long haul traffic forecasts are as follows:

- Baseline forecast - An estimate of orderly growth of market demand over the study period.

- Impacted baseline forecast - A modification of the baseline forecast to reflect the effect of specific events considered to fall outside of the definition of orderly growth.

- Net long haul traffic - A modification of the impacted baseline forecast to eliminate certain elements of market demand which do not meet the greater than 40 mile definition of long haul transmission.

The forecasts include all long haul traffic without regard for the method of implementation - whether terrestrial or satellite, whether analog or digital - and are stated in units of measurement as specified in the Statement of Work. Alternate units of measurement, common to all three service categories, are provided in subsequent sections of this study.

3.0 METHODOLOGY

Table II-1 depicts the basic flow of events required to generate the impacted baseline forecasts for each of the three service categories. The details of each step described in the flow of events will vary with the requirements of each service category - but the general methodology applies to all three service categories. The following is a brief description of the steps:

Table II-1 List of Steps Necessary to Generate Impacted Baseline Forecasts

- Identify service applications
- Prepare application description
- Establish current level of demand
- Prepare application scenarios
- Calculate baseline forecast (each service category)
- Apply market determinant factors
- Apply cross impacting relationships
- Calculate impacted baseline forecasts (each service category)

- Identification of the service applications represents a distillation of over 150 candidate applications, both existing and anticipated, into 31 applications deemed of sufficient importance for independent forecasting. The selected applications were chosen based on research generated from the Literature Survey (Task 1) and previous internal analyses. Each application tracked in the forecasting procedure met the requirements of sufficient level of market demand in the study period, and distinctiveness in usage or implementation.

- A description of each application was formulated which identified significant features and established parameters which separated it from similar applications. These parameters made it possible to avoid duplication of market demand where the line of demarcation between applications would otherwise be ill defined.

- The current level of demand for each application was determined through literature research, user surveys and interviews and internal market analysis and plans. This provided the starting point from which forecasts could be generated. The sum of market demand for all of the applications associated with each service category made up the current demand for that category.

- A scenario for each application was developed which included all events of a low risk, predictable nature. This allowed for forecasting market demand based on orderly growth and present visibility. Market trends were established based on historical data and were confirmed or modified as a result of research and supporting analytical information used througout the study. Duplicate demand, a potential problem when establishing forecasts for similar or competing

applications, was eliminated by scenario definition. This was possible because the objective was an orderly growth of demand and the independent scenarios reflected the realities of the total study market demand.

- The culmination of the general analysis to this point resulted in the baseline forecast by individual applications and summation into three service categories. The baseline forecast does not reflect the impact of higher risk events on specific applications and, therefore, does not completely reflect the true dimensions of the market. In order to make the proper adjustments to the baseline forecast, an impacted baseline forecast was generated for each service category.

- A series of market determinant factors were developed and quantified through research and analysis. These factors represent the impact of higher risk events which affect market demand. The factors generally apply to a single service application or small group of similar applications and their impact is related only to those specific applications. The quantification of these factors include market impact, market timing and a range of impact above and below the most likely or expected impact of each particular event.

- Certain cross impacting relationships arise when the market determinant factors are applied to the baseline forecast for each application. The cross impact generally affects pairs of applications by overstating the cumulative demand. This excess demand is eliminated by quantifying the cross relationships and applying the impact in concert with the determinant factors.

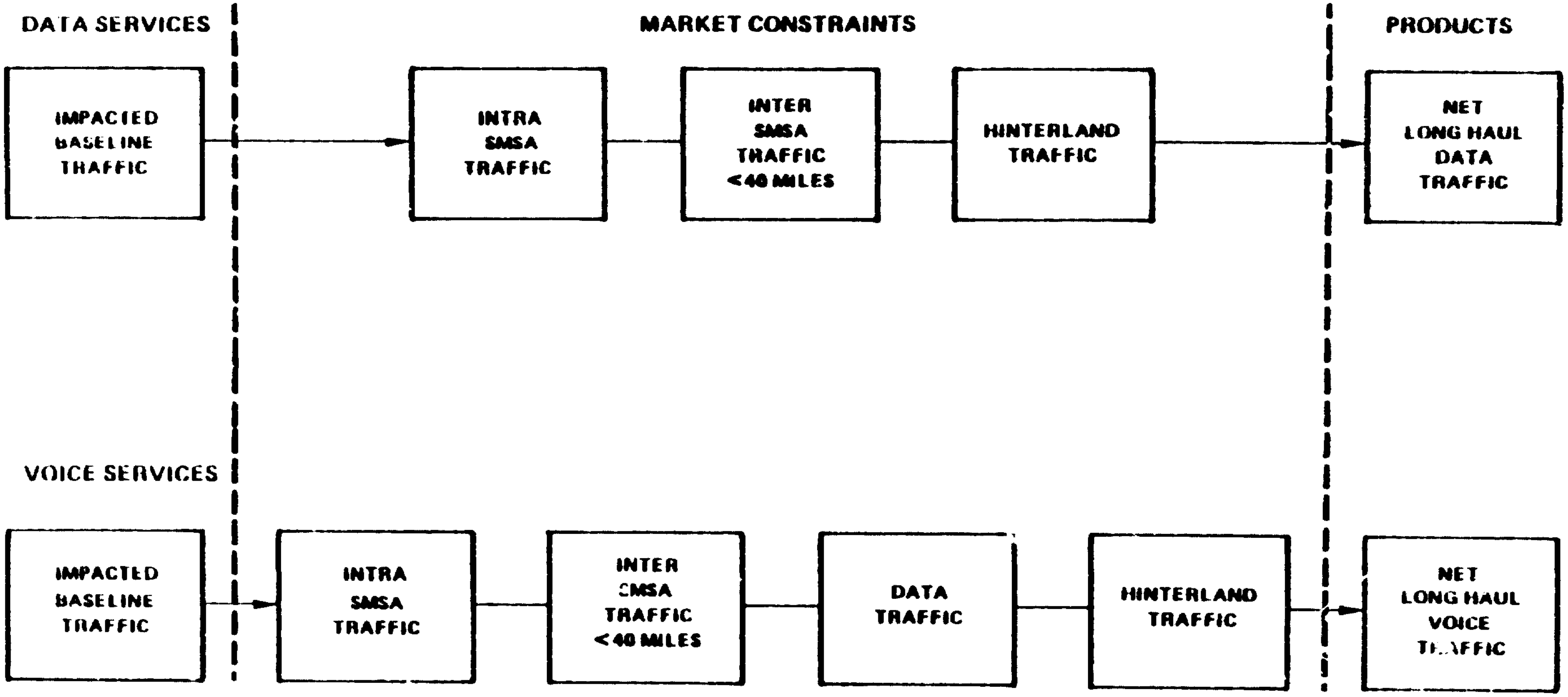
- The application of these modifying determinant factors and cross impacting relationships yields the impacted baseline forecast for each application and, when summed together, for each service category.

Figure II-1 depicts the basic flow of the analysis necessary to translate the impacted baselines into the net long haul traffic forecasts. Each service category starts with an impacted baseline forecast which is not directly relatable one to another. The steps shown in Figure II-1 make the necessary accommodations to yield net long haul traffic forecasts which are directly relatable to each other.

The function of each step is briefly outlined as follows:

- Traffic which does not leave a particular SMSA is defined as not being long haul in nature. Such intra SMSA traffic is excluded from the impacted baseline forecasts by the Market Distribution Model (MDM).

- Inter SMSA traffic of 40 miles or less is excluded from the forecasts by the MDM.



NET LONG HAUL TRAFFIC DETERMINATION

FIGURE II - 1

- Data category traffic implemented on voice facilities has been analyzed, converted to common units of measurement and removed from the voice category forecasts. This avoided a potential source of duplicated demand projections.

- Point-to-point traffic originating or terminating in the area beyond the geographical limits of the 275 SMSA's located in the contiguous 48 states is excluded. The proportion of market demand associated with this hinterland area is small and quantifiable for each service category. Its elimination permits the MDM to perform market distributions required in subsequent study tasks.

Application of these steps to the impacted baseline yields the net long haul traffic forecast for each service application. The summation of forecasts for the applications associated with each service category provides the net long haul forecast for that category.

3.1 Computer Modelling

Market research data gathered in the course of the study were manipulated, expanded, transformed and enhanced by the use of computer models and modelling techniques. Specifically, computer models were developed to track the baseline and impacted baseline forecasts, incorporate the impact of determinant factors and cross impacting relationships for all 31 applications over the 1980-2000 time period.

Several computer models were developed for this study and some previous models were enhanced in order to accomplish the massive data input, manipulations, and impacting criteria necessary to produce the required results. Existing computer models like the Market Distribution Model (MDM) were extensively used.

Some of the specific applications of modelling techniques used in this study were:

- A computer model to modify the baseline forecasts through the application of market determinant factors reflecting technological, competitive and regulatory developments, price elasticity and socio-economic variables over time.

- Cross impact modelling techniques permitted the removal of duplicate demand brought on by conflicting interrelationships between market determinant factors.

- Forecast modelling included such techniques as regression analysis, historical trend projections, time series analysis and other forecasting approaches based on varying growth rates.

- The Market Distribution Model (MDM), which incorporates a large number of market flow data bases, was used to provide sophisticated market analysis and traffic distribution.

The Market Distribution Model (MDM) is a computer model, which has the capability to incorporate a variable number of data bases. Each data base can be considered a "file" or fundamental block of data which can be manipulated, normalized, scaled or combined with other files. The model's information flow is shown in Figure II-2.

The three types of market research activities that MDM supported in the study were:

- The distribution of nationwide traffic forecasts to specific cites and routes.

- The ranking of cities or routes by their expected market potential for communications service.

- The projection of market forecast distribution using multiple data base profiles.

The MDM contains a coverage of 275 Standard Metropolitan Statistical Areas (SMSA's) which include:

- all major U.S. cities in the contiguous 48 states

- 72.4% of the total population

- over 37,000 possible routes

- approximately 85% of total communications traffic.

The fundamental capability of the MDM in creating a distribution of traffic relies on a series of data bases which closely represent or correlate with a communication service's characteristics. There are over 22 separate data bases in the model which cover six basic categories.

- population centers

- telephone locations

- industrial/business demographics

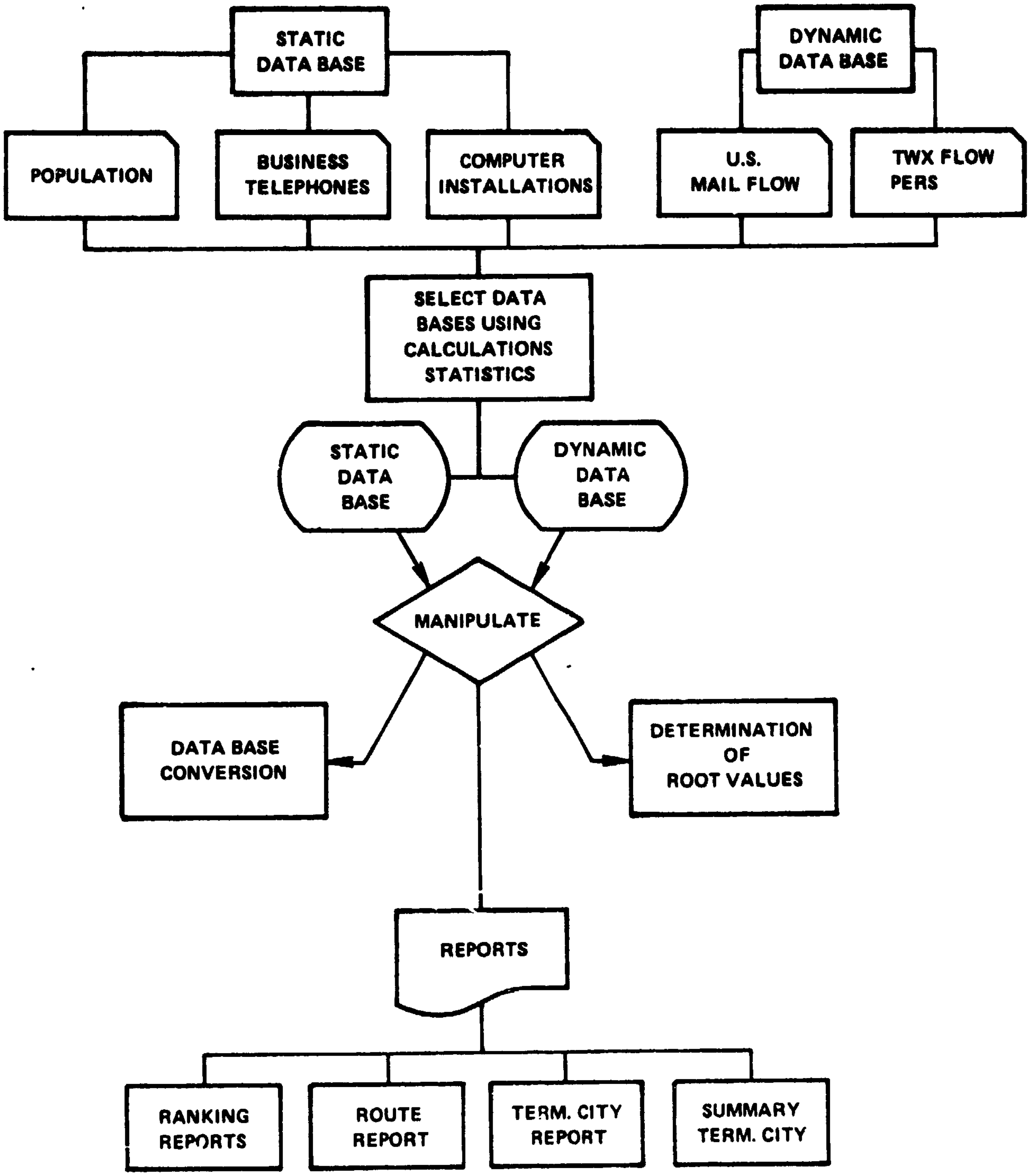
- computer values/locations

- U.S. mail flow

- specific communications activity

In order to effectively utilize this model, a series of steps must be followed:

1. Determine the desired geographic/market segment to be addressed.



MARKET DISTRIBUTION MODEL

FIGURE II - 2

2. Select a set of data bases from within the MDM which reflect the service's characteristics.

3. Develop weighting factors for each selected data base. The weighting factor represents a statistical measure which assigns a relative value to each data base to reflect their individual importance.

4. The computerized model is then utilized to record assumptions for the weighting factors, statistically validate applicability of data base selection to form a weighted sum of the data bases (all of which have been converted to percentages), and then use the distance sensitivity measure as an input to an algorithm which converts the total static data base to a dynamic (flow) one.

5. This newly formed dynamic data base is combined in a weighted fashion with the previously selected dynamic data bases to create a final SMSA paired service which contains a relative value measuring communication potential between all selected SMSA's.

6. This result is normalized so that the total of all individual route values between SMSA's sums to 100%.

7. The data file can now be used to examine the relative demand potential between SMSA pairs.

4.0 ANALYSIS AND RESULTS, DATA SERVICE CATEGORY

The analysis of the data service category follows the methodology previously outlined. In the calculation of the baseline forecast, the applications are identified and described, current levels of traffic are ascertained and scenarios of orderly growth are prepared so that forecasts can be generated. For the impacted baseline, market determinant factors are identified and quantified and cross impacting relationships established so that the forecasts may be calculated using computer modelling techniques. The net long haul traffic forecasts remove elements of demand as indicated previously in Figure II-1.

4.1 APPLICATION IDENTIFICATION

The data market was classified into four sub-markets based on service similarities, application characteristics, or equipment used in providing service. The major sub-market categories are:

- Data Transmission
- Electronic Mail
- Electronic Funds Transfer/Point of Sale (EFTS/POS)
- Miscellaneous (Secure Voice, Monitoring services)

A thorough search was essential to help compile a comprehensive list of data services and applications. Approximately 150 candidate applications were identified. However, there were certain similarities among many of them which helped in their consolidation into 18 existing and three anticipated service applications. These were tracked to generate the market demand forecasts. Figure II-3 summarizes the specific applications in each sub-market.

The process of consolidating 150 candidates into 18 current and three future applications necessitated their grouping by distinctive characteristics such as:

- Similar uses
- Similar methods of implementation
- Segregation by industry orientation

Only three new data applications were considered to exhibit sufficient market demand to justify their inclusion in the analysis. Research indicated that the greatest number of candidate anticipated applications are directly or indirectly linked to the home terminal market. However, most potential services to the home are local in nature and do not offer a significant long haul market demand during the time span associated with this study.

Data Transmission Applications (8)

- High Speed/Wideband
  - Data Transfer
  - Batch Processing
  - Data Entry (part)
- Low Speed/Medium Speed
  - Data Entry (part)
  - Remote Job Entry
- Interactive Transmission
  - Inquiry/Response
  - Private Timesharing
  - Commercial Timesharing
- Other
  - Packet Switching

EFTS/POS Applications (2)

- Inquiry/Response
- Data Entry/Data Transfer

Electronic Mail Applications (8)

- Restricted Access Networks
  - Administrative Message Traffic
  - Operational Facsimile
  - Communicating Word Processors
  - Convenience Facsimile
  - Mailbox Services
- Open Access Networks
  - TWX and Telex
  - Mailgram and Telegram
  - USPS EMSS (Future)

Miscellaneous Applications (3)

- Special Purpose Facsimile
- Secure Voice (Future)
- Monitoring Services (Future)

DATA SERVICE CATEGORY
(21 APPLICATIONS)
FIGURE II-3

The three anticipated applications included in the data service category are: Monitoring Services, an agglomeration of the non-interactive home status and utility services; Secure Voice, the encrypted, digitally transmitted service; and the U.S. Postal Service Electronic Message Service System (USPS EMSS) which is expected to appear in one form or another in the next decade.

4.2 APPLICATION DEFINITIONS

It was imperative that application definitions be prepared to make it possible to assign differing growth rates, usage characteristics, technical sensitivities and other operational aspects which influence the marketplace without duplicating demand or confusing application characteristics.

- Data Transmission Applications:

  1) Data Transfer is the process whereby information is electronically transferred from one storage bank (usually a computer) to another in a non-update fashion. The transfer usually takes place during off-peak transmission times.

  2) Batch Processing is best characterized as an activity that is volume rather than time-oriented and prepared according to a schedule rather than on demand. Typical examples include daily sales orders, weekly payroll information, etc.

  3) Data Entry is the process whereby information is captured in computer-readable format at its source and added to an existing database (eliminating the intermediate keypunch mode). Devices used in this application include general purpose and application unique terminals.

  4) Remote Job Entry (RJE) is the process of remotely controlling the initiation and termination of computer processing related to a specific job or run. Essentially, this remote control capability affords an operator the same level of processing capability as if he were within the computer facility. It differs from Data Entry in that RJE involves manipulation of the received data and transmission of the output to the originator after processing.

  5) Inquiry/Response is characterized by its urgency and is usually transmitted in a real-time manner by the use of operator-entered inquiries to an existing database which can be manipulated and corrected. Common applications include airline reservation systems, stock exchange quotations, item inventory status and account balances.

6-7) Timesharing is characterized by the shared use of centrally located computer facilities by several operating entities. The computer facilities can store, manipulate and transmit data simultaneously among the several users, generally on a real time basis. The supplier of the central computer facilities may be a commercial organization serving many unassociated users, Commercial Timesharing, or supplied privately serving in-house computing needs, Private Timesharing. (The distinction between commercial and private is made due to the different sources of market demand information.)

8) Packet Switching is a method of data transmission in which value-added carriers provide long-haul facilities, leased from common carriers, to a variety of independent users on a shared use basis. The user's data is broken into small blocks (packets) and transmitted at high data rates to the distant location over any of several paths on a best available routing basis. At the distant location the data is reassembled. Market demand assigned to Packet Switching in this study only reflects the increased traffic brought about by the availability of this application with its economies to certain users.

- Electronic Mail Applications

9) Administrative Message Traffic may be described as the data transmission of written correspondence between two or more locations which may be either intercompany or intracompany. Traffic may use store and forward techniques or be of an interactive nature where terminal operations at either end alternately send and receive. Equipment used may range from teletypewriters to sophisticated general purpose data terminals.

10) Operational Facsimile is defined as mail room oriented, high volume service with established intracompany routes. The high usage justifies high cost, high speed equipment operating at page transmission speeds of from two minutes (current maximum) to a few seconds in the foreseeable future. The original facsimile use for graphics is no longer paramount, with typed and handwritten documents being transmitted where time is a principal concern.

11) Communicating Word Processors (CWP's) add communications capability to a printer/keyboard or CRT based word processing system, allowing the input to be prepared on one system and sent via communication links to another system for output, editing or manipulation. CWP's have the

advantage of transmitting "original" quality documents with format control similar to letter and memo correspondence.

12) Convenience Facsimile provides a method of transmitting casual correspondence where time is important. Usage per machine is generally very low which results in the use of slow (4 to 6 minutes per page), low cost equipment with transmission via the dial-up public telephone network or intracompany private wire networks.

13) Mailbox Services are similar to Private Timesharing systems and generally use the same facilities. Access to the central computer memory allows messages to be deposited for later receipt by the terminal equipped recepient.

14) TWX and Telex are similar Western Union subscriber message services with the exception of transmission speeds, TWX transmitting at 100 wpm while Telex transmits at 66 wpm. Messages are transmitted from one teletypewriter type terminal to another and provide output in a hard copy format.

15) Mailgram service permits message input by data terminal or voice with transmission to the Post Office closest to the recipient for delivery in the next day's mail. Telegram is a Western Union record message service providing delivery of hard copy output with legal standing. Input is by terminal or by person with transmission to the Western Union telegraph office closest to the recipient for phone relay with immediate or delayed physical delivery.

16) The USPS Electronic Message Service System (EMSS) is a projected delivery system which would substitute overnight facsimile transmission between a large network of local Post Offices for up to one-half of the first class mail traffic. The service would employ digital wideband transmission facilities and be implemented in the early-to-mid 1980's. There are substantial uncertainties regarding the disposition of EMSS - but the possibilities of an equivalent service being available, publicly or privately operated, make this a viable application for market demand forecasting purposes.

- EFTS/POS Applications:

Electronic Funds Transfer Systems combine computer technology and data communications to provide a variety of basic financial services. Some of these services involve the actual transfer of funds from account to account, while others are purely informational such as credit checks prior to the acceptance of checks for payment of goods sold.

Point of Sale systems parallel the usage exhibited by EFTS. Some uses of POS systems involve credit checking, inventory updating, report generation and business data analysis.

17) EFTS/POS Inquiry/Response operation is similar to that found among the Data Transmission Applications. Principal differences in usage characteristics are shorter messages and shorter transmission distances.

18) EFTS/POS Data Entry and Data Transfer operation is similar to that found among the Data Transmission Applications. Principal differences in usage are larger networks per user and slower transmission speeds for data equipment.

- Miscellaneous Applications:

19) Special Purpose Facsimile users are publishing houses (e.g., Wall Street Journal) transmitting press ready copy for geographically distributed printing, weather bureaus sending complicated graphics for information and analysis, and news agencies and law enforcement sending photos and similar graphics. Distinguishing features of this application are special purpose high resolution equipment, high traffic levels and frequent use of wideband data transmission facilities.

20) Secure Voice utilizes digital transmission. Encryption of a digital signal is inexpensively obtainable and adds only a minimal extra data requirement. Good tonal qualities and speech inflections can be transmitted at data rates from 32 to 64 Kbps.

21) Monitoring Services include automatic billing of utilities, home security and fire protection, remote operation of home and office appliances and remote environment regulation. Delivery of these services to the home or office may be by phone or cable video connection. The long haul portion of the market demand is that part of the total passing in concentrated form to remotely located data processing and storage facilities. The greatest portion of traffic associated with Monitoring Services is local and is not included in the forecasts. Only traffic being transmitted beyond the local telephone serving area is analyzed.

4.3 BASELINE FORECAST

Analysis of current data category market demand is combined with the baseline forecasts.

Two scenarios were prepared for each data application. The low risk scenario reflected the effect of foreseeable events, technological innovations and service developments and yielded an orderly growth (or decline)

in market demand. The high risk scenario reflected the impact of possible occurrences and developments of technology or significant changes in the direction of the market caused by outside factors. Scenarios for orderly growth were defined in a manner which eliminated cross impact or duplicate demand between individual data applications.

4.3.a Baseline Forecast Determination

The total data service category baseline forecast market demand was generated by analyzing the 21 separate applications within a framework of orderly, low risk event growth. A detailed analysis was made to determine the appropriate method to estimate current and future traffic for each of the 21 applications. The forecasts reflect usage expressed in terms of terabits (bits x 10^{12}) per year. Several of the applications segregated government usage from that of other user categories to assist the user analysis required in Task 3.

The output of the literature survey, with confirmation from user and vendor surveys was used in deriving market demand and included such sources as equipment populations, usage characteristics, service revenues and other traffic related information. Application definitions and scenarios were prepared to prevent a duplication of demand.

Methods of forecasting market demand varied with the application being investigated and included analysis of general purpose data terminal usage, pages of facsimile transmission, revenue generated by services and estimates of market activity anticipated from new applications. Similarities among groups of applications made similar analysis methods appropriate. Four generalized approaches emerged:

- Applications associated with general purpose terminal and computer access port usage (13 applications)
- Applications utilizing facsimile (4)
- Record Services (2)
- Miscellaneous (2)

<u>Applications Associated with Terminals and Computer Ports</u>

Thirteen of the 21 applications being tracked used general purpose data terminals and/or ports associated with the larger classes of computers at the terminating ends of their channels and market demand is associated with the activity experienced by the channels. The applications are:

- Data Transfer
- Batch Processing
- Data Entry
- Remote Job Entry
- Inquiry/Response
- Private Timesharing
- Commercial Timesharing
- Packet Switching

- Administrative Message Traffic
- Communicating Word Processors
- Mailbox Services
- EFTS/POS Inquiry Response
- EFTS/POS Data Entry/Data Transfer

A brief methodology used for quantifying the market demand associated with general purpose terminals and computer access ports includes the following steps:

- Determine the general purpose data terminal population.
- Determine the population of access ports associated with the largest computers.
- Distribute terminals/ports among appropriate applications.
- Analyze data terminal/computer port preferred operating speeds.
- Analyze trends in preferred operating speeds.
- Distribute terminals/ports within applications by preferred operating speeds.
- Analyze usage characteristics for terminals/ports by application and preferred operating speed.
- Quantify usage in bits per year.
- Apply terminal/port usage to calculate market demand by application for 1978-2000.

All terminal and port populations were based on equipment currently in place with forecasts reflecting the consensus of vendor surveys and consulting market analysts through 1990. Market demand beyond 1990 was determined by the traffic trends exhibited by each application plus the scenario established earlier.

A synthesis of several consulting reports provided the most reasonable forecast of general purpose terminal population. A growth from 1,218,000 terminals in 1977 to 4,710,000 in 1990 was indicated. The total excluded TWX, TLX and special purpose terminals (which include department store registers, facsimile equipment, bank clusters, etc.).

A study conducted by industry sources indicated a population of Class 5, 6 and 7 computers which will support a quantity of wideband access ports that will grow from 5,000 56 Kbps equivalent capacity channels in 1977 to 11,100 in 1990 and from 93 1.5 Mbps equivalent channels in 1977 to 432 in 1990. These classes represent the three largest computer categories - the ones most often used for central processing and large database management.

The general purpose terminal population was distributed among the 13 appropriate data applications for 1977 on the basis of the output of the literature survey and the user surveys, both of which indicated a concentration of terminals among Inquiry/Response, Administrative Message Traffic and Commercial Timesharing applications.

The proportional distribution of terminals changes over time to reflect the growth of EFTS/POS and Packet Switching applications. This shift in distribution is at the expense of more mature applications such as Administrative Message Traffic and RJE. The distribution shift between 1977 and 1990 is shown in Table II-2.

Table II-2 - Distribution of Terminal Population by Application

APPLICATION	PERCENT DISTRIBUTION OF TERMINALS			
		1977		1990
Data Transfer		3		3
Batch Processing		5		3
Data Entry		10		9
High Speed	2		2	
Regular	8		7	
Remote Job Entry		10		8
Inquiry/Response		20		21
Private Timesharing		4		4
Commercial Timesharing		15		14
Packet Switching		1		2
Administrative Message Traffic		17		15
Communicating Word Processors		3		5
Mailbox Services		1		2
EFTS/POS Inquiry Response		10		13
EFTS/POS Data Entry/Data Transfer		1		1
		100		100

Analysis conducted in support of other planning activities was expanded to allow construction of a matrix which distributed the population of terminals and ports among eight specific preferred operating speeds over the 1977-1990 period.

PREFERRED OPERATING SPEED CATEGORIES

- under 300 bps
- 300 bps
- 1200 bps
- 2400 bps
- 4800 bps
- 9600 bps
- 56 Kbps (computer ports)
- 1.5 Mbps (computer ports)

Intermediate speeds were grouped in the next higher speed category with the exception of 19.2 Kbps, which was factored into the 9600 bps category on the basis of two for one.

Most general purpose data terminals are capable of operating at several transmission speeds. Preferred operating speed is defined as the most common speed associated with a particular application in a particular location. The speed may be influenced by usage characteristics such as on-line operator keyboard control, printer speed, transmission line quality or availability of wideband facilities. Each application is likely to be represented by several terminal/port speed categories.

The overall growth in the general purpose data terminal population through 1990 caused a net increase in the number of terminals in four of the six preferred operating speeds. The mix of speeds showed very large increases for 1200, 4800 and 9600 bps terminals at the expense of terminals operating below 300 bps. Among wideband computer port operating speeds, growth was much faster for 1.5 Mbps ports than for 56 Kbps ports. However, the total number of 1.5 Mbps ports continued to be very small.

Each of the 13 data applications was analyzed to estimate the distribution (by percentage) of terminals operating at each speed category - both currently and as projected for 1990. This matrix of estimates was then matched against the distribution of terminal/port population by preferred operating speed for the two years and a matrix of terminal/port populations for each application derived.

The usage characteristics of terminals for each preferred operating speed within each of the 13 appropriate applications were analyzed based on the results of user surveys and other sources. To simplify this analysis, only low, mean and high usage options were considered. These options were based on hours (or fractions of hours) of daily usage. The usage was not necessarily the same for different speed categories - mean usage ranged from 0.5 to 3 hours per (business) day among the six speed categories.

Usage was converted from on-line time to bits per year per terminal with a formula which took into consideration average operating speed, usage level, operating efficiency factor and time unit conversion factor. The resultant calculation was applied to the application/terminal population matrix so that an annual traffic level (expressed in terabits) was shown for each speed within each of the 13 data applications. The summation of this matrix yielded the market demand for these applications for the current (1977) and 1990 periods. These market demands are two points on the baseline forecast. The matrix summation also provided the market demand generated by each terminal/port speed

category for the same two periods. This type of information is required later in the study to give insight into the distribution of facilities when analyzing terrestrial/satellite cost crossovers and other traffic analyses.

Calculation of baseline market demand for intermediate years through 1990 and subsequent years to 2000 was accomplished by use of the application scenarios. The 13 terminal/port applications were analyzed with respect to their individual current market demands, maturity of application and changing potential growth rates (both as a reflection of historical patterns and when compared to other applications). An individual pattern of growth was developed for each which, when applied, closely matched the 1990 anticipated level of demand. Similar analyses of growth patterns were made for the 1990-2000 period and market forecasts were made for each of the 13 applications.

Applications Utilizing Facsimile

Four of the 21 applications being tracked used facsimile technology. The market demand associated with them is based on items such as installed equipment population, usage characteristics and specific traffic potentials. The applications are:

- Operational Facsimile
- Convenience Facsimile
- USPS Electronic Message Service System (EMSS)
- Special Purpose Facsimile

The market demand forecasting approach for the three current facsimile applications includes the following steps:

- Determine the current and forecasted populations for each category of facsimile equipment.
- Determine the usage associated with each category of equipment.
- Analyze usage trends for each application.
- Quantify usage in bits per year.
- Apply usage to equipment population to calculate market demand by application for 1978-2000.

All equipment populations and usage trends were projected to 1990. Market demand beyond 1990 was determined by assigning trend lines to each application as indicated by the scenarios.

Operational Facsimile equipment was defined as comprising the total population of medium (1-2 minutes per page) and high speed (subminute) machines. (Convenience use of machines in these operating speeds was discounted for ease

of analysis.) A composite of industry forecasts provided the estimates of equipment population. Medium speed machine population was indicated at 3,400 in 1978, growing to 13,900 in 1990. Subminute machine population was forecast as growing from 5,400 in 1978 to 78,200 in 1990. Usage per machine was analyzed from user surveys and other literature on the subject. Medium speed equipment transmitted about 200 pages per month per machine with no usage growth. (Greater usage would justify graduation to a faster machine.) High speed equipment currently transmits approximately 250 pages per month per machine with gradual growth to approximately 450 pages in 1990. This increase in machine usage coincides with expansion in the operational application. Average usage per machine will level off at the 450 page per month activity. An average of 150,000 bits per page of transmitted copy is estimated for the 1978-2000 period. This represents first generation white paper compression - and is considered a reasonable average for the likely mix of equipment to be employed during the period. (The raw rate for uncompressed facsimile material is approximately 935,000 bits per page.)

Convenience Facsimile equipment was defined as the population of slow speed (2-6 minutes per page) machines. A composite of external and internal estimates indicates the installed base to rise from 167,000 machines in 1978 to 717,000 in 1990 with negligible growth beyond 1990. A shrinkage in the installed base is not forecast - based on an estimate of a resale market which will transfer older machines to fringe users and a small replacement market adequate to offset scrapped equipment. Usage per machine was analyzed at 80 pages per month throughout the study period. Each page of copy was equated to 150,000 bits to simplify later calculations. (This type of machine normally transmits copy at the 935,000 bits per page rate. Use of the higher bit rate would have skewed the importance of this application in calculating the baseline forecasts.)

Special Purpose Facsimile equipment populations were also derived from industry forecasts which indicated a slow growth of machines from 10,000 in 1978 to 20,200 in 1990 with similar growth rates extending through the year 2000. Usage is based on a graphics equivalent of 10,000 8.5 x 11 inch pages per year throughout the study period. As high resolution output is one of the requirements associated with this application, 450,000 bits per equivalent page of copy has been assumed - including the effect of limited compression techniques.

USPS EMSS plans to employ very high speed facsimile equipment to transmit a certain proportion of first class mail between about 7,000 public terminals (branch Post Offices) operating through nearly 100 stations (nodes). Forecasts indicate a market potential of 24 billion pages per year when fully implemented operating on 56 Kbps and 1.5 Mbps facilities with overnight service to the distant Post Office. Using first generation white paper compression techniques, the overall transmission time per page should average less than 3 seconds. The baseline forecast for EMSS makes certain assumptions:

- Approximately 12 billion pages per year actual transmission at full implementation.

- Delayed probability of starting date
  - 50% in 1982
  - 30% in 1984
  - 20% in 1986
- Five year buildup of traffic before full implementation.
- 150,000 bits per page.

Record Services

Two of the 21 applications being tracked deal with services entirely provided by Western Union. Four services are addressed in the two applications:

- TWX and Telex
- Mailgram and Telegram

Market demand forecasts are collected from Western Union internal sources. The quantity of traffic, expressed in bits per year, is relatively small when compared to other data transmission applications. This is related to the slow transmission speeds used by the majority of the traffic.

Miscellaneous Applications

Two of the 21 applications being tracked are sufficiently unique to prohibit their inclusion in any of the previous three groupings. They are:

- Secure Voice
- Monitoring Services

The Secure Voice market demand forecast was based on an analysis of potential requirements among the various user categories. User surveys and a review of applicable literature were the basis of the market estimates which were quantified in detail for 1985. The estimates were extended to the year 2000 on the trends established in the application scenario. A 56 Kbps digital wideband channel is designated as the transmission medium to allow for quality encrypted voice reproduction. Secure Voice is carried as a data service application to segregate it from common voice service category applications where the proper level of privacy and availability may not be available. This is not to imply that regular voice applications will not carry occasional encrypted traffic.

Monitoring Services market demand forecasts were based on an analysis of potential in the year 2000. Usage characteristics such as message length and frequency were combined with basic statistical data such as population and households to yield the gross market potential. A level of usage appropriate

to the year 2000 was assumed to calculate the baseline forecast. A service buildup of 40% annually was imposed to quantify demand between 1990 and 2000.

4.3.b Baseline Forecast Results

Table II-3 shows the data service category baseline forecast for the years 1980, 1990 and 2000, expressed in terabits (bits x 10^{12}) per year.

Table II-3 - Baseline Forecast Data Category Terabits (Bits x 10^{12}) Per Year

	1980	1990	2000
Data Transmission Applications (8)			
High Speed/Wideband	751	3430	15268
Low Speed/Medium Speed	303	960	2543
Interactive Transmission	292	1539	6724
Packet Switching	12	110	1029
Subtotal, Transmission	1358	6039	25564
Electronic Mail Applications (8)			
Restricted Access Networks	190	910	3925
Open Access Networks	2	1210	1477
Subtotal, EM	192	2120	5402
EFTS/POS Applications (2)	68	476	2742
Miscellaneous Applications (3)	51	247	1105
Total, All Applications (21)	1669	8882	34813

Total demand will increase more than twentyfold between 1980 and the year 2000. Data transmission applications will increase over 18 times in that period and at the same time decrease in their share of the total market from 81% in 1980 to 73% in 2000. Electronic mail applications will increase their share of the total market from 11.5% to 15.5% during the 20 year period. The largest percentage increase in baseline market demand will be experienced by EFTS/POS applications which expanded over 40 times to reach an 8% share of the market in the year 2000.

The 20 year average annual growth rate (AAGR) for total data category demand between 1980 and the year 2000 is 16.4%. The individual AAGR's for the Data Transmission, Electronic Mail, EFTS/POS and Miscellaneous subcategory groupings are 15.8%, 18.2%, 20.3% and 16.6%, respectively.

4.4 IMPACTED BASELINE FORECAST

Scenarios for orderly growth used in developing the baseline forecast reflected predictable events which were consolidated for projection of the 21 data applications. Scenarios which describe less predictable events were generated through the use of market determinant factors and cross impact relationships.

Twenty two market determinant factors were quantified for use in modifying the data service category baseline forecasts. Each determinant factor identifies the probability of occurrence in a given year, the data applications affected by the factor and the impact of that effect quantified in percent of baseline demand for three cases; expected, high range and low range. The computation of these market effects by computer converts the baseline demand forecast into the impacted baseline forecast. The total effect of the factors is to increase the data service category market demand. However, individual factors may show declines in demand as well as increases.

An example of market determinant factors is shown in Figure II-4. Only determinant factors which are expected to have widespread market acceptance or use are quantified. The factors impact only specific data applications. Many factors affect more than one application and that effect need not be the same for each application. Some factors exhibit a positive effect on some applications and a negative effect on others. Approximately 225 separately quantified effects were generated by the 22 factors.

Over 30 additional market determinant factors were analyzed for their effect on the baseline forecast and rejected for use. Seven general reasons for excluding these factors were cited on a factor by factor basis. The reasons are indicated in Table II-4.

Table II-4 - Reason Event Not Included as Determinant Factor

- Event doesn't affect the domestic communications market demand
- Event is equipment oriented and doesn't directly impact transmission
- The market demand impact of event is trivial
- Significant impact of event won't occur until after year 2000
- Event is implementation oriented and doesn't significantly affect market demand
- Effects of event included elsewhere or combined with larger/more general event
- Effects of event are essentially local or short haul in nature

	YEAR OF OCCURRENCE	PROBABILITY	MARKET IMPACTS (%) LOW RISK	EXPECTED	HIGH RISK
● **TECHNOLOGY**					
FIBER OPTICS INSTALLED FOR INTERCITY TRANSMISSION	1988	20%	1	3	4
	1990	10%			
	1995	20%			
● **SOCIO/ECONOMIC**					
RAPID RISE IN ENERGY COSTS PROMOTE USE OF ELECTRONIC INFORMATION SERVICES	1984	20%	4	7	9
	1987	25%			
	1990	30%			
	1995	25%			

MARKET DETERMINANT FACTORS

(EXAMPLE)

FIGURE II - 4

Figure II-5 is an example of a cross impact relationship of the type used to eliminate duplicate demand in forecasts after the application of determinant factors which are judged to be in conflict. Cross impact modelling is used to transform analytical perceptions into a quantitative tool for demand forecasting.

The impacted baseline forecast is generated from the baseline forecast by applying the market determinant factors and the cross impacting relationships to the baseline in the manner just described. Table II-5 shows the expected case of the impacted baseline market demand for 1980, 1990 and the year 2000.

In the year 2000, the impacted baseline market demand (expected case) was 23% over that forecast for the data service category baseline. The AAGR for the impacted baseline was 17.6% for the 20 year period versus 16.4% for the baseline. All subcategory grouping AAGR's also increased with Electronic Mail reaching 21.5% of total data demand (versus 20.3%).

Table II-5 - Impacted Baseline Forecast Data Services Category
Expected Case Summary (Terabits)

	1980	1990	2000
Data Transmission Applications (8)			
High Speed/Wideband	751	4235	19374
Low Speed/Medium Speed	305	1144	3067
Interactive Transmission	296	1849	8103
Packet Switching	12	111	1029
Subtotal, Transmission	1364	7339	31573
Electronic Mail Applications (8)			
Restricted Access Networks	192	1152	5257
Open Access Networks	2	1210	1431
Subtotal EM	194	2362	6688
EFTS/POS Applications (2)	69	585	3363
Miscellaneous Applications (3)	51	273	1211
Total, All Applications (21)	1678	10559	42835

- CROSS IMPACT MODELING IS USED TO TRANSFORM PERCEPTIONS AND ASSUMPTIONS INTO A QUANTITATIVE EVALUATION TOOL
- CROSS IMPACT ANALYSIS WILL HELP ELIMINATE DUPLICATE DEMAND FORECASTS
- IT CAN BE COMPUTER MECHANIZED TO DETERMINE IMPACT OF CHANGING JUDGEMENTS AND PERCEPTIONS

SAMPLE CROSS IMPACT DIGITAL MARKET MATRIX
(May include numerous events)

	THEN THIS EVENT IS AFFECTED		
IF THIS EVENT OCCURS	Facsimile Market Demand	Digital Services Market	CWP Market Demand
Low Cost High Speed Digital Fax Introduced	++	+	(—)
Widespread Digital Transmission Facilities	+	++	+
Compatibility Standards For CWP's	0 (—)	+	++

CROSS IMPACT INTERRELATIONSHIPS

FIGURE II - 5

Table II-6 shows the range of data category market demand for 1980, 1990 and 2000. The high and low boundaries diverge from the 1978 starting point until approximately 1990, where the range is plus 11% and minus 9%. The following decade shows very little additional divergence. This is the result of the application of the market determinant factors which are mostly resolved by 1990 and their impact on demand stabilized. For additional information, the baseline forecast market demand was included in the table so that a comparison with the impacted baseline could be presented.

Table II-6 - Impacted Baseline Forecasts
Range of Forecasts
Data Service Category - Terabits

	1980	1990	2000
High Range	1708	11724	47526
Departure from Expected Case	+ 1.8%	+ 11.0%	+ 11.0%
Expected Case	1678	10559	42835
Increase from Baseline	+ 0.1%	+ 18.9%	+ 23.0%
Low Range	1665	9649	38600
Departure from Expected Case	- 0.8%	- 8.6%	- 9.9%
Baseline Forecast	1669	8882	34813

4.5 NET LONG HAUL TRAFFIC FORECAST

The net long haul traffic is the balance remaining after intraSMSA traffic, interSMSA traffic on routes of 40 miles or less and hinterland traffic has been removed from the impacted baseline forecast of market demand.

4.5.a Net Long Haul Traffic Forecast Determination

- IntraSMSA Traffic

A certain proportion of each data application traffic does not leave the SMSA in which it originated. By definition, this traffic does not qualify as long haul and must be removed from the forecasts. Each of the 21 data service category applications was analyzed for this type of traffic and a portion of the market demand excluded. Quantification of intraSMSA traffic was done by professional judgment based on user survey insights and a review of the appropriate literature. Excluded traffic ranged from 70% to zero for specific applications. The most heavily influenced applications were EFTS/POS Inquiry/Response

and Commercial Timesharing, which lost more than half of their market demand at this point. Least influenced application was USPS EMSS which, by definition, does not exchange traffic within the same SMSA. Other applications which lost only small fractions of market demand were Packet Switching and all Facsimile and Record Service applications. These applications depend on the long haul transfer of data for their existence.

- InterSMSA Traffic on Routes of 40 Miles or Less

The Market Distribution Model (MDM) has identified all routes of 40 miles or less in length and has assigned market values to them. These values, expressed in percent of total market demand and unique to the data service category, equitably quantify the portion of total market demand appropriate for exclusion at this step and were applied to all data applications. A total of 163 of the 37,675 routes connecting the 275 SMSA's are 40 miles or less in length.

- Hinterland Traffic

The data service category was analyzed as a whole and a proportion of the traffic which either originated or terminated at a point outside one of the 275 SMSA's was excluded. This was necessary in order to make the distribution of traffic manageable by the Market Distribution Model. A rationale can be developed to support the exclusion of this type of traffic in that the traffic density in the hinterland is too sparse to support viable interconnection with the rest of the market through satellite means. (As the object of this study is long haul satellite traffic, it is appropriate to make this exclusion at this time.) Various studies and computer analyses made by Western Union on the nature of traffic distribution have indicated one overriding conclusion: the more sophisticated the nature of the traffic being studied, the more concentrated it is among the larger metropolitan centers. Data traffic is therefore concentrated in the SMSA's to a greater extent than the raw population statistics would indicate. The population of the 275 SMSA's represents 72.4% of the contiguous states' total. The proportion of data service category traffic was then quantified to be 85% of the total. Fifteen percent of the total market demand was excluded at this step.

- Data Traffic Carried on Analog (Voice) Facilities

The data service category net long haul traffic forecast has been calculated on the basis of market demand - without consideration of the transmission facilities used. The voice service category has been calculated in a similar manner. However, the voice forecasts, which were based on historical growth patterns, included facilities on which data traffic was implemented. If the forecasts were not modified to acknowledge this situation, a duplication in market demand would be caused.

It was decided that the data service category forecasts should remain whole and that the voice service category should be reduced by the amount of the data traffic carried. This would allow the data market demand to remain intact as an aid to subsequent market analyses.

The methodology used to convert applicable data traffic (expressed in terabits per year) to voice traffic (expressed in half voice circuits) included the following steps:

- Analyze each data application to determine the nature of the traffic: peak oriented; off-peak oriented; one-way; two-way or special.
- Derive a conversion factor to convert terabits per year to half voice circuits which takes nature of traffic into account.
- Calculate equivalent voice facilities load for all data traffic.
- Analyze each data application to determine the proportion carried on voice facilities in 1978, 1980, 1990 and 2000.
- Calculate net voice facilities carrying data traffic and reduce voice service category forecasts by a like amount.

Very few dedicated data facilities are currently in use. In 1978, approximately 99% of data traffic was carried on voice facilities. Anticipating the emergence of digital facilities, the weighted average of data on voice facilities declined to 98% in 1980, 76% in 1990 and 37% in 2000. When compared to the total market demand for Private Line and MTS (Business) facilities, the voice applications normally carrying data traffic represent 9.8% in 1978, 10.8% in 1980, 16.8% in 1990 and 12.3% in 2000.

4.5.b Net Long Haul Traffic Forecast Results

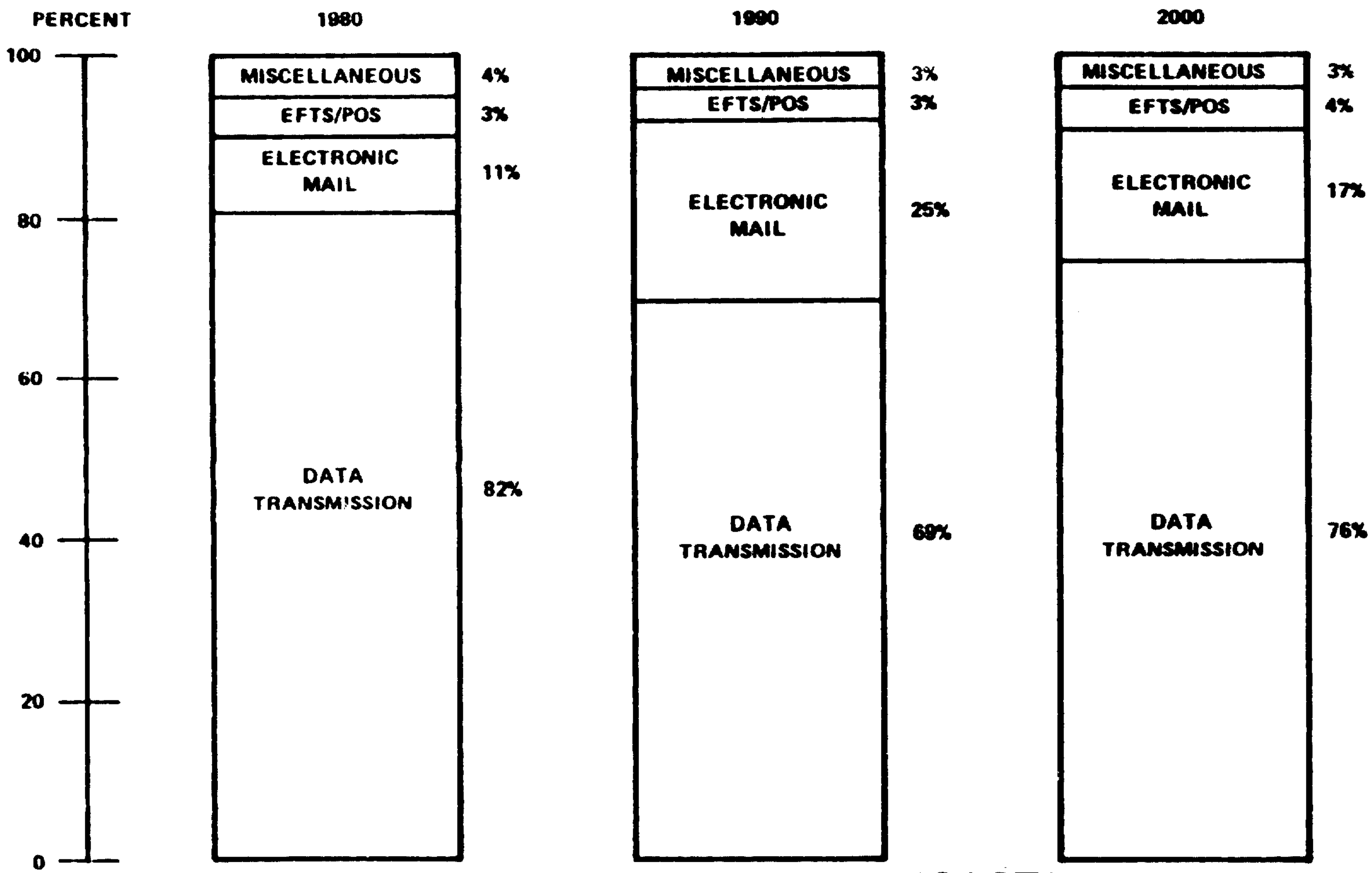
Table II-7 shows the expected case of the net long haul traffic forecast for 1980, 1990 and 2000. The total net long haul traffic demand shows a decline of over 35% in the year 2000 from the impacted baseline demand. Similar declines are associated with the other forecast years because of the relatively uniform cumulative effect of the removal of short haul and hinterland traffic from the mix of data applications.

The relative share of the market held by each subcategory grouping remains similar between the impacted baseline demand and the net long haul traffic forecasts. EFTS/POS applications are an exception because of the greater portion of local traffic associated with this grouping. In the year 2000, the EFTS/POS share of the market demand drops from 7.8% in the impacted baseline forecast to 4.3% share in the long haul forecast. A similar, but smaller, decline in market share is shown for the Interactive group of data applications. Figure II-6 shows the percentage distribution of the four data subcategory groupings for the years 1980, 1990 and 2000.

The 20 year average annual growth rate for the total data category net long haul traffic is 17.6%. The AAGR's for the Transmission, Electronic Mail, EFTS/POS and Miscellaneous subcategories are 17.1%, 19.8%, 20.7% and 16.9%, respectively.

Table II-7 - Net Long Haul Traffic Forecast
Data Category - Expected Case Summary (Terabits)

	1980	1990	2000
Data Transmission Applications (8)			
High Speed/Wideband	524	2971	13660
Low Speed/Medium Speed	200	750	2013
Interactive Transmission	155	991	4410
Packet Switching	9	87	810
Subtotal, Transmission	888	4799	20893
Electronic Mail Applications (8)			
Restricted Access Networks	122	731	3383
Open Access Networks	2	1003	1185
Subtotal, EM	124	1734	4568
EFTS/POS Applications (2)	27	216	1178
Miscellaneous Applications (3)	40	208	914
Total, All Applications (21)	1079	6957	27553



NET LONG HAUL TRAFFIC FORECASTS
DATA SERVICES

(TERABITS PER YEAR)

FIGURE II - 6

5.0 ANALYSIS AND RESULTS: VOICE SERVICE CATEGORY

The Statement of Work required the voice service category forecasts to consider inclusion of leased and switched network long line telephone service, mobile radio telephone and radio program transmission. The analysis of the voice market indicated that the switched network Message Telephone Service (MTS) contained two substantially dissimilar applications, residential service and business service. This consideration, plus the consolidation of other telephone usage and pricing structures, indicated that five voice applications would be adequate to meet the forecasting requirements of the study and still contain sufficient identity to be directly used in the analyses associated with subsequent tasks.

Table II-1 and Figure II-1, discussed in the methodology section of Task 2.A, show the flow of steps required to create the baseline, impacted baseline and net long haul traffic forecasts for the voice service category. The methodology parallels that described in substantial detail in the analysis of the data service category, discussed previously. The analysis of the voice service category is abbreviated in areas where the calculation processes are identical to those used in the data category.

Market demand source material for several of the voice category applications segregated interstate and intrastate traffic. Separate forecasts were maintained for each demand segment until a point in the calculations had been reached where their different characteristics were no longer significant.

5.1 APPLICATION IDENTIFICATION

Five applications were identified for the voice service category. They represent the consolidation of several additional similar or minor applications and provide the visibility required for this study.

- Private Line
- MTS (Public)
- MTS (Business)
- Radio Program Transmission
- Mobile Radio Telephone

5.2 APPLICATION DEFINITIONS AND SCENARIOS

Private Line application includes all full period and dedicated facilities including those of the Telpak-type provided by all carriers. Private lines are channels leased for use between specific points, are primarily used for voice transmission, and are priced at a flat monthly rate regardless of the volume of traffic carried. Service may be provided on terrestrial or satellite facilities by both common and specialized carriers. Telpak-type service is a bulk package of facilities offered by AT&T, Western Union and

many other carriers which provides discounts based on the number of full time channels leased. Services include voice-grade, telegraph and broadband channels. Federal and State government agencies and large corporations are the principal Telpak customers. Private line and Telpak forecasts were based on 25 years of historical information and included Bell and competitive carriers. Multipoint or multidrop circuits are treated as separate lines, counting each section as a separate channel. AT&T and competitive filings with the FCC were used to identify actual and estimated two-way interstate voice circuits. The forecasts of expected growth patterns and baseline forecasts through the year 2000 resulted from historical extrapolation and market research documents. Since study results are presented in units of half voice circuits, a doubling of duplex circuit forecasts was made.

Public Message Telephone Service (MTS) includes both the residential and coin categories of metered, switched service as provided by the Long Lines Division of AT&T and other telephone operating companies. (Coin telephone long distance service has decreased so drastically in importance that it was not deemed significant to allocate this traffic between the MTS, Public, and MTS, Business, applications.) MTS (Public) traffic projections were based on trends established on 25 years of historical data obtained from AT&T filings and in-house documents. MTS activity is expressed in terms of billions of revenue minutes which were equated to units of half voice circuits - making a consistent unit of measurement for all voice service category applications.

Business Message Telephone Service includes business subscribers of the switched and metered MTS and WATS-type (Wide Area Telephone Service) bulk usage services. These services are provided principally by AT&T-Long Lines Division and other telephone operating companies and to an increasing degree, by other non-Bell carriers.

WATS is a special bulk-rate arrangement for directly dialed station-to-station toll telephone service provided by AT&T Long Lines and other Bell operating companies. Five bands, or geographic areas of service coverage, are provided at varying tariffs. Measured Time WATS includes ten hours of monthly usage with overtime billed at a flat metered rate. Full Business Day WATS includes 240 hours of usage per month. Intrastate WATS is also available.

MTS (Business) forecasts were based on 25 years of historical information from AT&T filings. Activity is expressed in billions of revenue minutes which were converted to half voice circuits for the forecasts.

Radio Program Transmission involves the dissemination of information to a number of receiving stations simultaneously. This application has been segregated into three segments for the purposes of analysis:

- Scheduled or Network Program Channels
- "Occasional" Program Channels
- FM Mail

The inherent difficulty of assessing multipoint broadcast services on an equivalent facilities basis was overcome by equating the requirements to satellite type distribution.

Three qualities of radio program transmission were considered:

a. 15 KHz high fidelity channel for high quality stereo and entertainment

b. 8 KHz intermediate quality channel

c. 4 KHz normal voice grade, ı 'atively low quality channel.

Various conversion equivalencies were used to equate demand in units of half voice circuits. The most important segment of the Radio Program Transmission application demand is related to the scheduled network programs aspect. It is reasonable to predict that satellites will soon become the principal means of network program distribution. Both the National Public Radio and the Mutual Broadcasting System are expected to implement nationwide satellite networks on Western Union WESTAR facilities in 1979; the other leading networks - ABC, CBS, NBC and the National Black Network - may be expected to use satellite facilities by the mid 1980's.

"Occasional" program channel demand is expected to increase during the study period, although at a slower rate than scheduled channel demand. During the period 1970-1978, before the impact of satellite transmission was realized, the AM station market was nearly saturated. As a result, most of the new growth is taking place in the FM market. The inherent local coverage of FM broadcasting restricts programming content, reducing preview and sports coverage over extended periods. This trend to localism, to some extent promoted by regulatory means, can be expected to moderate the rate of growth of "occasional" satellite demand, at least for the next several years.

FM Mail, which is defined as the distribution of data of any sort over a subchannel carrier of the FM band, is expected to show rapid growth in one market niche - distribution of highly specialized publications It will compete with those information dissemination services that will make use of the unused portion of the broadcast television signal. The greater share of FM Mail applications will be local, though intercity applications like the Physician's Radio Network will grow.

The Mobile Radio Telephone application is defined as a service connecting the public switched telephone network to mobile units. Service is provided by Bell telephone operating companies and/or radio common carriers.

Mobile Radio Telephone forecasts were based on an analysis of this market using 10 years of FCC historical data concerning the number of subscribers to both Bell subsidiaries and Radio Common Carriers (RCC's). The traffic projections take into account the increased demand anticipated when the nationwide cellular mobile radio system is implemented in the 1985-1990 time frame. The mobile radio traffic was considered to interconnect with the nationwide telephone distribution network but long-haul trunking requirements were held separate. These intercellular trunking requirements were

reported as the demand forecast.

Two categories of mobile radio telephone services were identified:

- Land mobile radio telephone
- Air-to-ground radio telephone

Subsequent analysis of the air-to-ground radio telephone demand based on available literature, proved to be inconsequential when compared to other voice application market demand and was ignored.

5.3 BASELINE VOICE SERVICES

5.3.a Private Line

Substantial historical data exists quantifying the AT&T portion of the interstate private line market including Telpak services, both in terms of circuits and revenues. Consultant studies have indicated the proportion and trend of non-Bell participation in this market. This participation (excluding Telpak) is increasing from approximately 19% in 1975 to an estimated 22% in 1980. Total interstate private line demand in 1980 is forecast to be 901,000 half voice circuits rising to 4,604,000 in the year 2000.

Revenue information is available for both inter and intrastate private line demand. Deriving a cost per line ratio of 1.4 to 1 for inter and intrastate private lines, the revenue data indicates a distribution of 72.3% interstate and 27.7% intrastate demand. The following Private Line voice application demand may be calculated, expressed in thousands of half voice circuits (Table II-8).

Table II-8 - Private Line Circuit Forecasts
(Thousands)

	1980	1990	2000
Interstate	901	2093	4604
Intrastate	345	802	1764
Total Private Line	1246	2895	6368

5.3.b Message Telephone Service (MTS) and WATS

Historical data is available for MTS traffic which documents such details as revenue, revenue minutes, holding time per message, diurnal distributions, etc., for each segment of MTS: residential, business and coin. The principal trends revealed in analyzing this information were as follows:

- Residential MTS will continue steady growth ranging from 10.4% per year currently to 7.8% by the year 2000

- The AAGR for coin MTS is minus 10%, which will essentially eliminate this segment by the year 2000

- Business MTS exhibits a relatively low growth rate of 3% to 4% per year throughout the 20 year period.

WATS-type service historical documentation is somewhat less reliable because of the developing nature of the concept. (WATS was introduced in 1961 and a considerable number of enhancements have been made since 1967.) The explosive growth associated with WATS is more a feature of a relatively small early demand, rather than a sustainable level of growth. The conservative approach to forecasting WATS-type demand has, nonetheless, made it the largest segment of the voice service category by the year 2000.

The following MTS (Public) and MTS (Business) applications' interstate demand may be calculated, expressed in billions of revenue minutes (Table II-9).

Table II-9 - Message Telephone Service Traffic
(Billions of Minutes)

	1980	1990	2000
Residence MTS	33.6	79.8	171.6
Coin MTS	0.2	0.1	neg.
Total MTS (Public)	33.8	79.9	171.6
Business MTS	14.0	19.9	27.1
WATS	13.6	65.4	253.4
Total MTS (Business)	27.6	85.3	280.5

Calculations of trunking requirements to convert revenue minutes to half voice circuits were made and confirmed by analysis of existing MTS-type facilities. The conversion factor, which is expected to remain constant with respect to time, is 55,000 revenue minutes per half voice circuit.

Ratios of interstate to intrastate demand for MTS and WATS traffic were determined by analyzing revenue figures and deriving the relative prices of inter and intrastate revenue minutes. The ratios calculated indicated that 59.5% of MTS and 71.1% of WATS traffic was interstate in nature. The MTS (Public) and MTS (Business) application demands are as follows, expressed in thousands of half voice circuits (Table II-10).

Table II-10 - Message Telephone Service Forecasts
(Thousands, Half Voice Circuits)

	1980	1990	2000
Interstate	615	1453	3120
Intrastate	418	989	2124
Total MTS (Public)	1033	2442	5244
Interstate	502	1551	5100
Intrastate	274	729	2208
Total MTS (Business)	776	2280	7308

5.3.c Radio Program Transmission

The total baseline demand associated with this application is trivial when compared with the three principal voice applications. The number of channels required is associated with the number of national radio broadcasting entities - which form a very limited group. Only the 15 KHz stereo entertainment grade channel generates any real transmission bandwidth requirement. In normal protected implementation, each 15 KHz channel uses the bandwidth associated with approximately 75 half voice circuits. All non-entertainment 4 and 8 KHz channels can be distributed on ordinary single or paired voice grade telephone facilities. The baseline forecast for the Scheduled/Network and Occasional segments of the Radio Program Transmission application is as follows, rounded to the nearest thousand half voice circuits (Table II-11).

Table II-11 - Radio Program Transmission Forecast
(Thousands, Half Voice Circuits)

	1980	1990	2000
Scheduled/Network	1	4	5
Occasional	0	3	3
Total RPT	1	7	8

The FM mail segment of this application contributes only negligible amounts of demand.

5.3.d Mobile Radio Telephone

Information available from FCC tariff documents (both AT&T and Radio Common Carriers) and consultant study reports enumerated total subscribers for land mobile radio telephone over a 10 year period beginning in 1965. Analysis of this data developed subscriber growth trends through the year 2000. Traffic loads per mobile radio telephone were hypothesized over the time span of the study and permitted estimations of total traffic forecasts by year. The consensus of expectation is that 12% of the total traffic will be long haul in nature. A conversion factor was applied to the total forecast (expressed in revenue minutes of traffic per year) to yield a baseline forecast in half voice circuits.

Baseline demand for the Mobile Radio Telephone application, expressed in thousands of half voice circuits, is 7 in 1980, 37 in 1990 and 80 in the year 2000.

Table II-12 shows the voice service category baseline market demand forecast for 1980, 1990 and 2000. The three principal applications account for 99.5% of the total demand in the year 2000 and for similar proportions in the other years.

The largest increase in market demand among the three principal applications during the 20 year period was an over nine fold expansion in MTS (Business) traffic. This represents an AAGR of 11.9% compared with 8.5% for both Private Line and MTS (Public).

Table II-12 - Baseline Market Forecast
Voice Services

(Half Voice Circuits)
(Thousands)

Application	1980	1990	2000	Average Annual Growth Rate
Private Line	1246	2895	6368	
MTS (Public)	1033	2442	5244	
MTS (Business)	776	2280	7308	
All Other	8	44	88	
Total	3063	7661	19008	9.6%

5.4 IMPACTED BASELINE FORECAST

The methodology used to convert the baseline forecast to an impacted baseline has been discussed previously. The two steps shown in

Table II-1 are the application of the quantified market determinant factors and cross impacting relationships for voice applications. In the voice service category, there are nine determinant factors which generate 12 separately quantified effects. Because of the mature nature of the three principal voice applications, the effect of the market factors is relatively small and there are no cross-impacting relationships.

Table II-13 shows the expected case, voice service category impacted baseline forecast. A more detailed summary of the impacted baseline, including the high and low ranges of demand and the separation of inter and intrastate traffic has also been prepared and is shown in the Appendix.

The impacted baseline forecast, expected case, indicated 7.2% greater demand in the year 2000 than was indicated on the baseline forecast. The average annual growth rate for total voice demand for the 1980-2000 period is 9.9% with the MTS (Business) growth rate of 12.1% the greatest among the three major applications.

Table II-13 - Impacted Baseline Market Forecast
Voice Services

(Half Voice Circuits)
(Thousands)

Application	1980	1990	2000	Average Annual Growth Rate
Private Line	1250	3032	6718	
MTS (Public)	1034	2577	5870	
MTS (Business)	777	2390	7681	
All Other	8	50	102	
Total	3068	8049	20371	9.9%

5.5 NET LONG HAUL TRAFFIC FORECAST

The steps necessary to calculate long haul voice service category demand from the impacted baseline forecast have been shown previously on Figure II-1. These steps are discussed in this section only to the degree that the calculation process differs from that described in the data service category section.

5.5.a IntraSMSA Traffic

Interstate intraSMSA traffic is defined as the short haul traffic within an SMSA which crosses a state boundary. Examples among the largest of the 275 SMSA's are New York, Philadelphia and Washington, D.C., all of which have a portion of their intraSMSA traffic crossing state lines. Over 30 of

the 275 SMSA's were found to cross state boundaries. Analysis revealed a correlation between interstate traffic and the proportion of total population represented by SMSA's crossing state lines. Approximately 2% of all interstate voice traffic was intraSMSA in nature and not compatible with long haul transmission.

Nearly 90% of the SMSA's cover geographical areas in only one state. A proportion of the traffic originating in these SMSA's does not meet the long haul criteria of the study and must be excluded. Intrastate MTS and Private Line traffic within an SMSA can be categorized as follows:

a. From suburban area to distant suburban area within the same SMSA

b. To suburban areas within the SMSA from the metropolitan area to the suburbs (still from the core city of the SMSA beyond the local dialing area).

Analyses of population and intrastate intraSMSA traffic patterns (similar to that performed for interstate intraSMSA traffic) show a positive correlation quantified as 13% of all intrastate voice traffic.

5.5.B InterSMSA Traffic Less Than 40 Miles

The Market Distribution Model (MDM) automatically calculated the voice category market value of these 163 routes. This represented the exclusion of 3.3% of total voice category market demand. (The 163 routes represented 0.432% of the total 37,675 routes.)

5.5.C Data Traffic Carried on Analog (Voice) Facilities

This traffic was quantified as part of the data service category analysis and converted into half voice circuits which were removed directly from the voice category to avoid a duplication in forecasted demand.

5.5.D Hinterland Traffic

The rationale for the exclusion of hinterland traffic was developed in considerable detail in the data service category analysis previously discussed. There is no technical reason prohibiting satellite service to hinterland locations - but the dispersed nature of market demand associated with rural areas creates economic barriers to effective inclusion of this market segment.

Quantification of this traffic for the voice service category yielded a weighted average of 20.6% of the total voice market demand initiating or terminating in the area outside any of the 275 SMSA's. Eighteen percent of each of the Private Line and MTS (Business) applications' demands was hinterland traffic; compared to 25% of the MTS (Public) application demand.

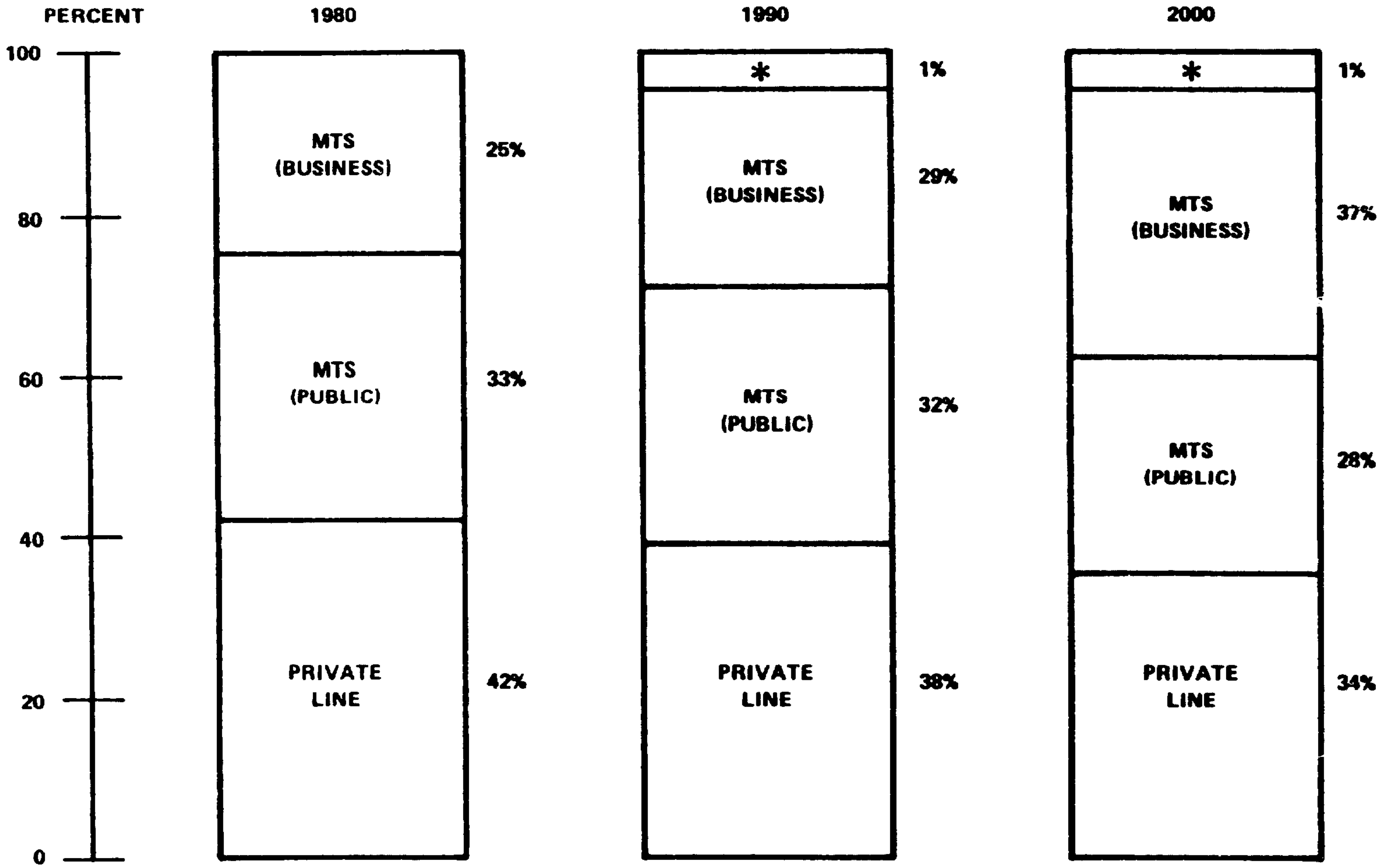
Table II-14 shows the net long haul traffic forecasts for the five voice service category applications for the years 1980, 1990 and 2000. The overall reduction in total demand from that cited in the impacted baseline forecast ranges between 31% and 34% over the 20 year period.

Table II-14 - Net Long Haul Traffic Forecast
Voice Services

(Half Voice Circuits)
(Thousands)

Application	1980	1990	2000	Average Annual Growth Rate
Private Line	883	2030	4677	
MTS (Public)	690	1721	3920	
MTS (Business)	518	1517	5078	
Radio Program Transmission	1	7	8	
Mobile Radio Telephone	7	41	89	
Total	2099	5315	13771	9.9%

The shares of total long haul demand for each voice application are shown graphically in Figure II-7. The increasing share of MTS (Business) from 1980 (25%) to 2000 (37%) reflects the high AAGR (12.1%) of this application. The AAGR for total long haul demand is 9.9% for the 20 year period.



* MOBILE AND RADIO PROGRAMMING - 1%

NET LONG HAUL TRAFFIC FORECASTS
VOICE SERVICES

(HALF VOICE CIRCUITS)
FIGURE II - 7

6.0 ANALYSIS AND RESULTS: VIDEO SERVICE CATEGORY

The Statement of Work required the video service category forecasts to include network and CATV distribution, occasional use TV, educational broadcasting, teleconferencing and telemedicine and video phone applications. Review of these and many other video applications allowed the organization of the video service category demand into five applications, each distinctive in the method of transmission, usage characteristics or source of market information.

Table II-1 discussed in the methodology section of Task 2.A, shows the flow of steps required to create the baseline and impacted baseline/long haul forecasts for the video service category. The methodology for assessing demand for video applications is simpler than that used for the data and voice service categories. This is due to some unique characteristics of video service and the ability to collect market information in a manner which permits the elimination of several intermediate steps in the demand calculations.

The two principal transmission formats employed by video applications are: one-way point-to-multipoint broadcast channels; and, point-to-point channels (either one-way or two-way). Both formats tend toward long haul transmission: point-to-multipoint, because the farthest distant point determines its long haul requirement, and point-to-point, because most local requirements can be satisfied by face-to-face meetings without an electronic link. With this consideration in mind, video service category market data was collected and organized in a way to prepare demand information with the local/long haul separation clearly separated.

6.1 APPLICATION IDENTIFICATION

Approximately 40 candidate video applications were analyzed and those with similar characteristics were consolidated into five major applications, many with appropriate usage segments separately identified.

- Network Video
- Occasional Video
- CATV Distribution
- Teleconferencing
- Interactive Home Video

6.2 APPLICATION DEFINITION AND SCENARIOS

6.2.a Network Video

Network Video utilizes dedicated full-time facilities for point-to-multipoint broadcast transmission. (Although an important method of

measurement, audience hours of viewing, appears to be decreasing, free television still reached 97% of all U.S. households in 1977.) Two types of program distribution affect demand:

- Iterative program distribution, meeting the prime time programming needs of affiliated stations in the various time zones.

- Multiple program distribution, offering several programs simultaneously, permitting affiliated stations to choose their own network programming fare.

Network Video can be segregated into four distinctive segments:

- Public Broadcasting System (PBS)

- Commercial network distribution

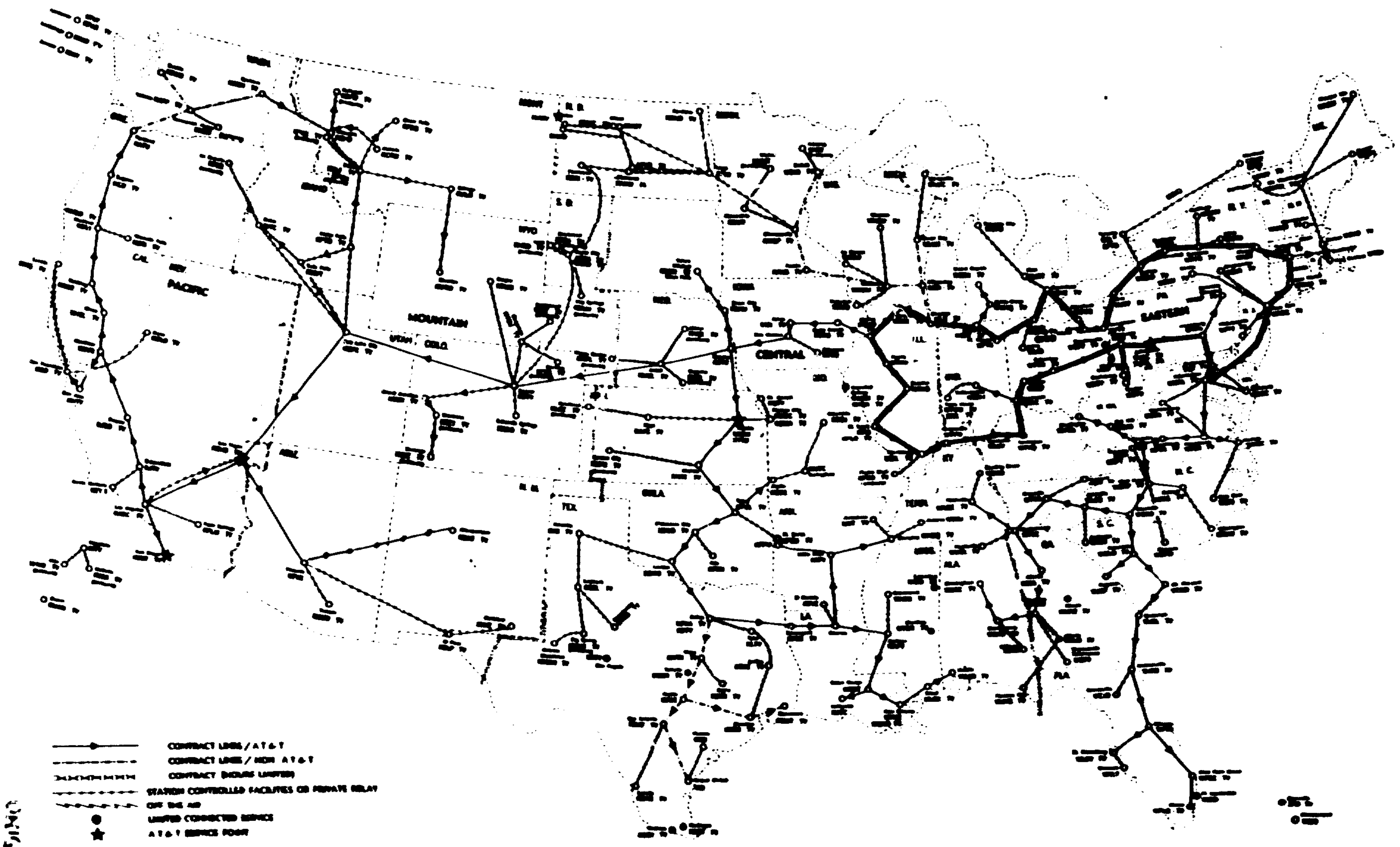
- Commercial network trunking

- Educational networks

Existing PBS program distribution market needs are currently being satisfied by 3 satellite transponder channels. A fourth satellite channel is under contract to be activated in 1980. Activation of additional channels can be expected, given the demands of domestic film producers and the public service community for satellite access.

Commercial network distribution may be accomplished by two alternative means - terrestrially, with a snake-like microwave network interconnecting affiliates, or by satellite, with two or more transponders accomplishing program delivery to the four CONUS time zones. A typical commercial network of approximately 200 affiliates, using terrestrial distribution techniques, is shown in Figure II-8. The adequacy of existing terrestrial distribution facilities and the burden faced by the commercial networks in reequipping their affiliates for satellite program reception dictate that commercial network program distribution will not be accomplished via satellite until at least 1990. In 1990, it is estimated that one of the three commercial networks will transfer its program distribution from terrestrial to satellite facilities. By 1995, the remaining networks will have made the changeover. It does not seem likely that today's three full-time commercial networks will be joined by other full-time commercial networks during the study period. Each commercial network, when committed to the satellite, will require approximately 8 channels to facilitate normal distribution, time zone delays, commercial insertions, and remote pickups. To accommodate the three major networks, 24 satellite transponders will be required by 1995.

Educational networks, engaged in regional rather than nationwide program distribution, will require a great number of full-time video channels. It is estimated that 25 state networks and 1 regional terrestrial network are



TELEVISION NETWORK

FIGURE II - 8

in operation today distributing educational programming. Originally carrying both PBS and local programs, generally, they now distribute only the latter, operating on a limited schedule. Only slight growth in the number of educational networks is expected during the study period. Transference of program delivery to satellite is expected to be minimal through the year 2000.

6.2.b Occasional Video

Occasional Video program distribution is generally required by video distributors who do not have full-time delivery requirements. Such requirements can usually be anticipated far enough in advance to permit scheduling by the suppliers of these facilities - both terrestrial and satellite.

Occasional Video channel requirements were calculated based on projected traffic and projected average effective channel utilization. It was assumed that three carriers would provide the Occasional Video facilities during the 1980-2000 study period, Western Union, RCA and AT&T, sharing the market in various proportions according to in-house analysis. Total demand, in hours, was divided by 1550, the average channel utilization in hours per year, to yield forecasts of channel requirements. Adjustments to the growth of the Occasional Video market were made to the 1990, 1995, and year 2000 forecasts to reflect the diversion of this type of traffic by the full-time commercial networks to their own satellite distribution systems.

6.2.c CATV Distribution

Multiple-city CATV Distribution networks usually include terrestrial, MDS, and satellite facilities, with a strong trend toward the latter. In the satellite distribution case, the population of affiliate-owned small earth stations interconnects the space segment (which is leased by the program distributor) and the cable head end. About 20% of the households currently using television are "on the cable", according to documented studies.

Five distinctive types of programming are available on cable systems:

- Religious
- Sports
- Pay
- Independent
- Other

Several industry sources have projected the growth of demand for satellite channels engaged in the long-distance delivery of such programming. Until 1985, essentially the point of program saturation at the head end, demand for satellite implementation will grow significantly. Terrestrial demand, principally the distribution requirements of the remaining independents, will remain relatively constant.

6.2.d Teleconferencing

Teleconferencing is used principally by corporations, government agencies and institutions to facilitate the conduct of meetings. The traffic is expected to be point-to-point and point-to-multipoint. Digital technology is likely to be incorporated in teleconferencing.

Three video teleconferencing arrangements are analyzed:

- Full-Motion
- Limited-Motion
- Slow-Motion

In each arrangement, quantification is particularized by user group: corporations, government agencies, and institutions. It was assumed that an average application would involve three points of termination. The potential user market is formed by 525 corporations, 100 government agencies, and 50 institutions. In addition, an analysis of the demand for full-motion channels (equivalent to transponders) supporting AT&T's Picturephone Meeting Service (PMS), which addresses public demand, is included.

- Full-Motion Video Conferencing

Demand in equivalent transponders for full-motion video conferencing facilities, which currently use 22 Mbps bandwidth, will be significantly influenced by a 2-for-1 transponder compression - expected by the mid 1980's.

- Limited-Motion Video Conferencing

Limited-motion video may be provided on 6.3, 3.1 or 1.544 Mbps facilities. A single 30 Mbps wideband video channel can accommodate a mix of 20 one-way limited motion video conferencing channels. Limited motion arrangements will show the largest percentage increase in actual usage of the three video conferencing arrangements over the period of the study.

- Slow-Motion Video Conferencing

Slow-motion video will employ 56 Kbps channels which can be accommodated at the rate of 100 per 30 Mbps wideband channel. In the satellite delivery system, it is likely that a large proportion of conferences will have direct-to-the-user channels via small, rooftop/parking lot antennas located on the users' premises. Substantial expansion of usage is forecast between 1980 and the year 2000, but the quantity of full transponder channel transmission facilities will remain the smallest of the three video arrangements because of the smaller bandwidths required per channel.

Projected demand for slow-scan video conferencing channels, which employ voice grade channels, has not been included in this analysis. Although

demand may become significant at some point, it will be lost in the overall demand for voice grade telephone service.

6.2.e Interactive Home Video

The vast majority of traffic for the Interactive Home Video application will be local or short-haul in nature, limited by usage characteristics and the quantity of facilities required. An analysis of the long-haul traffic segment is the basis for the application forecast.

Determination of demand for this application included the following market elements:

- the total number of cable television systems
- the proportion of cable systems (related to time) having both in excess of 12 channels and interactive capability
- the number of subscribers to qualified cable systems and those desiring intercity video service
- usage per interested qualified subscriber
- facilities necessary to handle the demand.

The analysis determined that no significant demand would occur before 1995 - and even with a rapid buildup of traffic, total demand would only occupy a very limited number of wideband channels by the year 2000.

6.3 BASELINE FORECAST

The unit of measurement specified for the video service category was the wideband channel. By agreement, this channel was to have the capacity to carry a commercial broadcast quality, full-motion video signal. Two problems arose when trying to equate different video requirements to common wideband channels. First, terrestrial and satellite definitions differ with regard to what constitutes a channel. Second, analog point-to-multipoint and digital point-to-point facility requirements are substantially different.

The method used to equate the terrestrial/satellite channel quantity variances was to use an equivalent satellite channel. In point-to-point transmission, one terrestrial circuit does the same work as two satellite half circuits. However, in point-to-multipoint transmission, such as is encountered in network broadcasting, there may be one sending point and 200 receiving points. This may mean a requirement for 200 terrestrial circuits - while two satellite half circuits could do the same job.

The analog/digital implementation problem was resolved by reducing the bandwidth requirement for a video wideband channel used in a point-to-point application from 50 Mbps, the full transponder equivalent, to 30 Mbps. The scenarios for C-band and Ku-band satellite systems, as used in this study, set

a number of operational criteria. Among the criteria for the C-band system was the concept of an analog FDM signal with a CONUS illumination, excellent for multipoint signal distribution. For the Ku-band system, the concept was for a digital TDMA signal with illumination by a number of spot beams - a method more suited to point-to-point traffic. A 36 MHz C-band transponder was assigned a net usable digital equivalence of 50 Mbps - the same as the Ku-band nominal transponder. Currently, a commercial broadcast quality video channel requires the use of a full C-band transponder - principally because of the power requirements needed to illuminate the CONUS footprint. A similar quality digital video channel, transmitted from point-to-point, would only require 22 Mbps of bandwidth. (Both the analog and digital facility requirements are expected to be reduced in the next decade - and forecasts have taken that improvement into account when forecasting market demand.) Therefore, Network, Occasional and CATV Distribution video applications will continue to require a full 50 Mbps transponder per wideband channel, while the teleconferencing and Interactive Home Video applications can be implemented on 30 Mbps per wideband channel in 1990 and 2000. To equate wideband channels to equivalent (50 Mbps) transponders, the Teleconferencing and Interactive Home Video channel count were multiplied by a factor of 0.6. (Wideband channels for all applications were equated to 50 Mbps in 1980 because no digital system will be available until early in the 1980's.)

This method of collecting video service category market demand permitted an initial separation of traffic addressable by satellite implementation and traffic addressable by terrestrial implementation. Table II-15 shows the baseline market forecast for the five video applications for the years 1980, 1990 and 2000. The units of measurement are wideband channels, and, for reference purposes, demand is also shown in equivalent (50 Mbps) transponders.

6.4 IMPACTED BASELINE/NET LONG HAUL MARKET FORECAST

Conversion of baseline forecast demand to an impacted baseline involves identifying and quantifying determinant factors affecting video service category applications. In the video service category, there were seven factors which generated 10 separately quantified effects. Because of the manner in which demand for the five video applications was derived, no cross-impacting relationships between applications were perceived due to the effect of determinant factors.

The analysis and calculation of the video category demand has equated the market demand of the impacted baseline to that of the net long haul traffic. Steps in the derivation of long haul traffic which were appropriate to the data and voice categories are not applicable to the video category. Video program distribution on a multipoint basis eliminated the necessity for analyzing intraSMSA and interSMSA traffic of 40 miles or less or that portion which terminates in the hinterland. Analysis of point-to-point video applications has been structured in such a way as to eliminate these steps also.

Table II-15 - Baseline Market Forecast
Video Service Category

(Satellite Equivalent Video Wideband Channels)

APPLICATION	1980	1990	2000
Network Video	45	52	59
Occasional Video	29	39	40
CATV Distribution	79	84	88
Teleconferencing	23	92	149
Interactive Home Video	0	0	5
Total, wideband channels	176	267	341
(Total, equivalent 50 Mbps transponders)	(176)	(230)	(279)

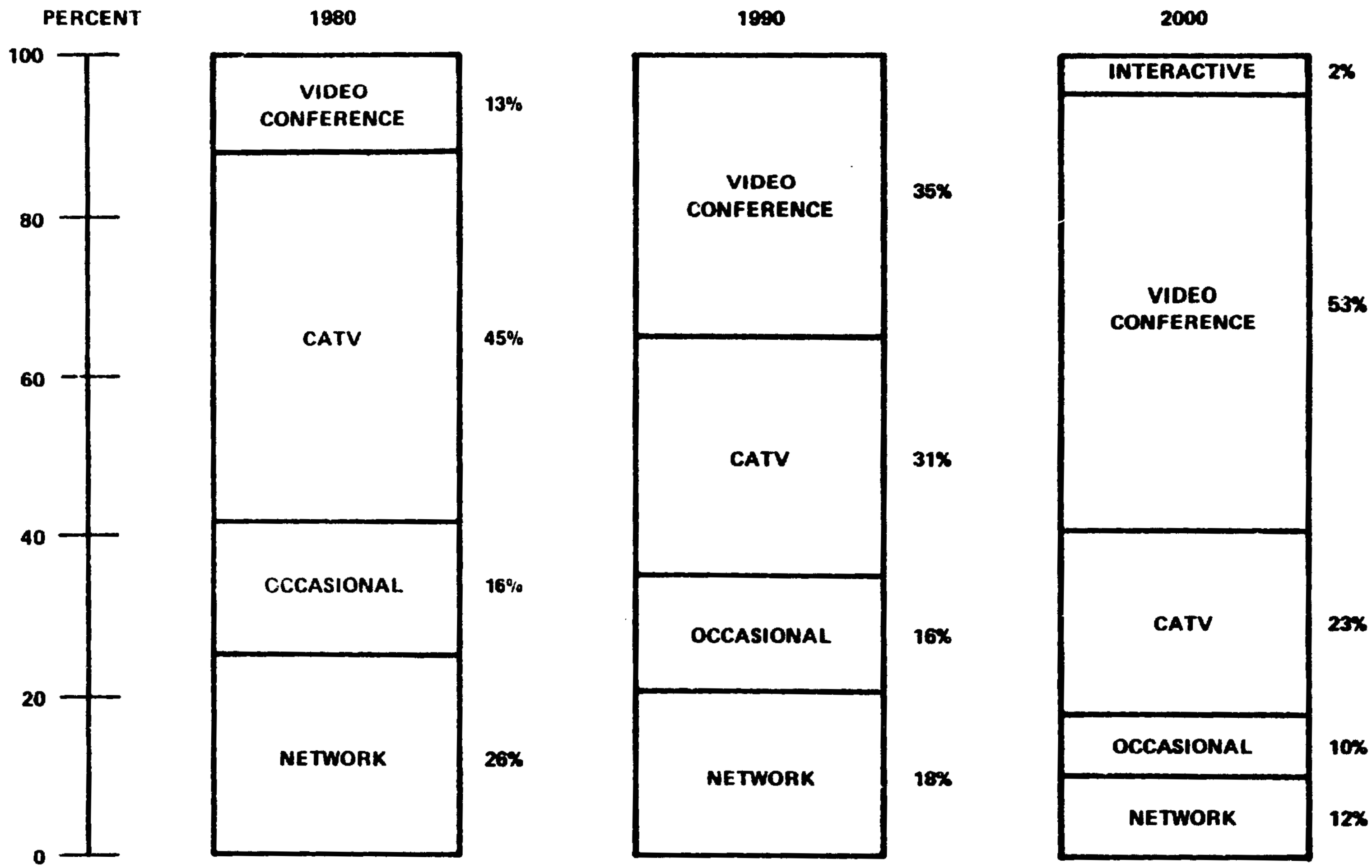
Table II-16 shows the combined impacted baseline and net long haul traffic market forecasts in the same format as was used for the baseline forecast.

The impacted baseline/long haul traffic combined forecast shows an increase over the baseline of 34% in the year 2000 and 9.5% in 1990. The greatest increases among the individual applications in the year 2000 were Interactive Home Video, up 90%, and Teleconferencing, up 62%. Figure II-9 shows the share of the video service category market changes between 1980 and 2000. Teleconferencing (Video Conference) increases its share of demand (when expressed in wideband channels) from 13% in 1980, to 53% in the year 2000.

Table II-16 - Impacted Baseline/Long Haul Market Forecast
Video Service Category - Expected Case

(Satellite Equivalent Video Wideband Channels)

APPLICATION	1980	1990	2000
Network Video	45.0	52.0	59.0
Occasional Video	29.0	46.8	48.0
CATV Distribution	79.0	91.2	99.4
Teleconferencing	23.0	103.6	242.0
Interactive Home Video	0	0	9.5
Total, wideband channels	176.0	293.6	457.9
(Total, equivalent 50 Mbps transponders)	(176)	(252)	(357)



**NET LONG HAUL TRAFFIC FORECASTS
VIDEO SERVICES**

(WIDEBAND CHANNELS)

FIGURE II - 9

7.0 CONSOLIDATED RESULTS AND CONCLUSIONS

Table II-17 shows the baseline, impacted baseline and net long haul traffic forecasts for 1980, 1990 and the year 2000 for each of the three service categories, expressed in the units of measurements specified in the Task 2 Statement of Work. By definition, the impacted baseline and the net long haul traffic forecasts for the video service category are the same as the requirements for video service imply a transmission distance of at least 40 miles.

The 1980 variance between the baseline and impacted baseline is very small because most determinant factors used to modify the baseline forecasts do not come into play until after 1980. The variance by the year 2000 ranges from 7.2% for the voice service category to 34.3% for the video service category. The small increase in the voice category reflects the maturity and predictability of the applications which make up that category. The video and data (23.0% variance) service categories are in a much greater state of flux and the determinant factors play a much greater part in forming their impacted baseline forecasts.

The reduction in market demand between the impacted baselines and the net long haul forecasts for the voice and data service categories are nearly the same, about 34%, for 1980, 1990 and the year 2000 for both service categories. This is due to the nature of the qualifying factors used to determine the forecasts. They reflect demographic criteria, in the main, and are less affected by time or application than was the case when determinant factors were involved.

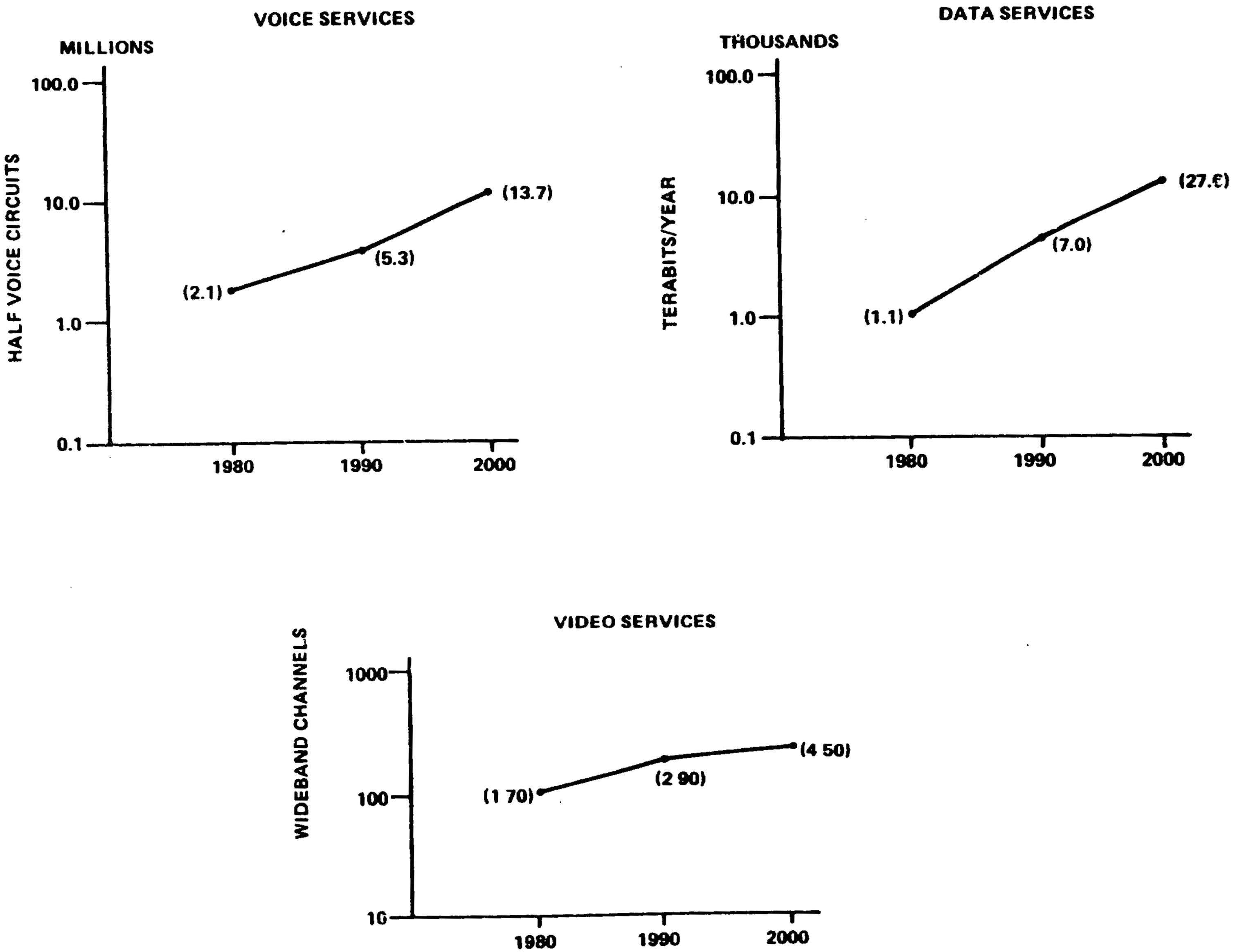
Figure II-10 depicts the growth rates associated with each of the three service categories, based on the net long haul traffic forecasts. The slope of the lines connecting the 1980, 1990 and year 2000 market demand represents the average annual growth rate, the steeper the line - the greater the growth rate. In this figure, the greatest average annual growth rate is exhibited by the data service category; 20.5% between 1980 and 1990, and 14.8% between 1990 and the year 2000 for a 20 year rate of 17.6%. Voice service category AAGR's are 9.7% in the first decade and 10.0% for the second decade for a 20 year rate of 9.9%. Video service category growth is 5.3% between 1980 and 1990 and 4.5% from 1990 to the year 2000, for a 20 year rate of 4.9%.

Table II-18 shows the impacted baseline and net long haul traffic forecasts for each service category converted to peak hour megabits per second. The method of making this conversion is discussed in subtask 5.C. The output represents the quantity of facilities necessary to support the peak hour traffic load for each of the three categories, expressed in a common unit of measurement - megabits per second. For the purposes of this table, all voice and video forecasts are converted to Mbps at their digital equivalents. This makes comparisons between years and between categories more clear and is couched in the digital terms which are carried through in the determination of Ku-band and 18/30 GHz digital satellite system market demands. The calculations of Table II-18 show that, in digital terms which accentuate the dominance of voice category applications, over 90% of total telecommunications demand resides in voice services - with video and data applications

Table II-17

Communications Market Forecasts
Expected Case Summary - Years 1980-2000

Year	Market Forecast	Voice Half Voice Circuits (x 1000)	Video Wideband Channels	Data Terabits/Year
1980				
	Baseline	3063	176	1669
	Impacted Baseline	3068	176	1678
	Net Long Haul	2099	176	1078
1990				
	Baseline	7661	267	8882
	Impacted Baseline	8049	294	10559
	Net Long Haul	5315	294	6957
2000				
	Baseline	19008	341	34813
	Impacted Baseline	20371	458	42834
	Net Long Haul	13771	458	27553



NET LONG HAUL TRAFFIC FORECAST

FIGURE II - 10

comprising the remainder. The higher growth rate of data demand between 1980 and the year 2000 increases its proportion of the total as time progresses. The lower growth rate of video demand during this 20 year period diminishes its proportion of total demand. By the year 2000, video and data long haul traffic require similar quantities of facilities to support their network requirements.

Table II-18

Communications Market Forecasts
Expected Case Summary - Years 1980-2000 - Mbps
(Thousands)

		Voice		Video		Data		Totals	
Year	Market Forecast	Mbps	Percent	Mbps	Percent	Mbps	Percent	Mbps	Percent
1980	Impacted Baseline	98.2	91.2	8.3	7.8	1.1	1.0	107.6	100.0
	Net Long Haul	67.2	88.2	8.3	10.9	.6	0.9	76.2	100.0
1990	Impacted Baseline	257.6	93.2	12.6	4.6	6.2	2.2	276.4	100.0
	Net Long Haul	107.1	91.2	12.6	6.8	3.7	2.0	186.5	100.0
2000	Impacted Baseline	651.9	93.5	17.9	2.6	26.9	3.9	696.7	100.0
	Net Long Haul	440.7	92.8	17.9	3.8	16.0	3.4	474.5	100.0

TASK 2.B DISTANCE DISTRIBUTION OF TRAFFIC

1.0 STATEMENT OF WORK

The Contractor shall provide estimates of the volume of voice and data communications traffic as a function of the distance it is transferred for the years 1985, 1990 and 2000.

2.0 INTRODUCTION

The net long haul traffic volume forecasts prepared in Task 2.A for two service categories, data and voice, were distributed as a function of the distance transferred. Market values for each of the 275 SMSA's were determined using the internally designed Market Distribution Model (MDM). A total of 37,675 traffic routes were analyzed which included all possible combinations for any two of the 275 SMSA's in the 48 contiguous states. Mileage distributions were collected in six airline mileage bands which were designed to offer the best perspective of traffic/distance relationships for later analysis. Although video traffic volume forecasts were prepared in Task 2.A, the broadcast nature of a large portion of the market did not lend itself to a traffic/distance analysis.

2.A GENERAL OVERVIEW

Distinct traffic patterns were developed for the two service categories and traffic concentrations were established for selected transmission distances. The MDM provided the capability of distributing traffic volumes as a function of distance thereby providing a means of determining relationships between the two factors. Traffic internal to an SMSA or between SMSA's less than 40 miles apart was not included as a part of the analysis. The length of routes connecting pairs of SMSA's is expressed in air line miles. SMSA longitudes and latitudes are identified in terms of V&H coordinates, maintained as a part of the MDM, which permit the calculation of route distances.

2.B APPROACH

Six airline mileage bands were established to develop a distribution of traffic by distance transmitted. They accommodated all significant mileage/distance categories that would be used in other analytical efforts within the study. The structure of the six mileage bands was designed to provide practical and usable mileage groupings that would satisfy the requirements of the study. For ease of analysis the groupings were similar though not identical to AT&T Long Lines mileage bands.

Short haul traffic is defined as transmission distances of 40 miles or less and was designated as the first band (0-40 miles). This would not be applicable to the long haul traffic objectives of the overall study. Routes greater than 40 miles were segregated into five mileage band categories shown in Table II-19.

3.0 METHODOLOGY

The net long haul traffic forecasts developed in Task 2.A were used for this task. Market demand associated with each service category was determined using computer modelling. Each interSMSA route had a market value associated with it determined by the MDM, the values of the two SMSA's constituting the route's origin and destination, and the MDM's internal algorithms. Six airline mileage bands were selected and the MDM provided the basic algorithms to distribute the routes among these bands. A traffic distribution profile was generated as a function of distance for each service category. Computer modelling efforts are explained in greater detail in the following section.

4.0 COMPUTER MODELLING EFFORT

The MDM was used to prepare traffic volume forecasts as a function of distance for voice and data services. This model development is based on a community of interest structure. It utilizes a total of (21) databases classified by: population, industrial activity, existing communications networks, and industrial market evaluations. Examples of actual databases are U.S. population statistics and the Western Union Telex/TWX subscriber base.

Usage profiles were established for the voice and data service categories and incorporated into the MDM through the selection and weighting of specific MDM databases. This was done as a part of analyzing and forecasting market demand in Task 2.A. These profiles were used to identify two separate distributions of market demand among the 275 SMSA's and the associated 37,675 SMSA-pair routes. Each route was assigned a portion of the total voice or data service category market demand. An ordering sort was performed by the MDM in which each route, and its associated proportional market demand, was collected in one of the appropriate six mileage bands. The summarization of proportional market demand for each mileage band completed the computer modelling effort.

5.0 PRESENTATION OF RESULTS

The distribution of long haul voice traffic by distance transferred is displayed in Figure II-11. Percentage distributions of the aggregate market demands as calculated by the MDM are shown for the year 1990. Market demand on routes in the 0-40 mile band was not applicable to this task and only the number of routes is reported. Table II-20 shows the weighted route densities for long haul voice services. Route densities were calculated by dividing the percent distribution of market demand for each mileage band by the percentage of total routes of each mileage band. The third mileage band (151-500 miles) had the highest percentage of traffic volume; the second mileage band (41-150 miles) had the highest percentage of traffic volume per route (Table II-20).

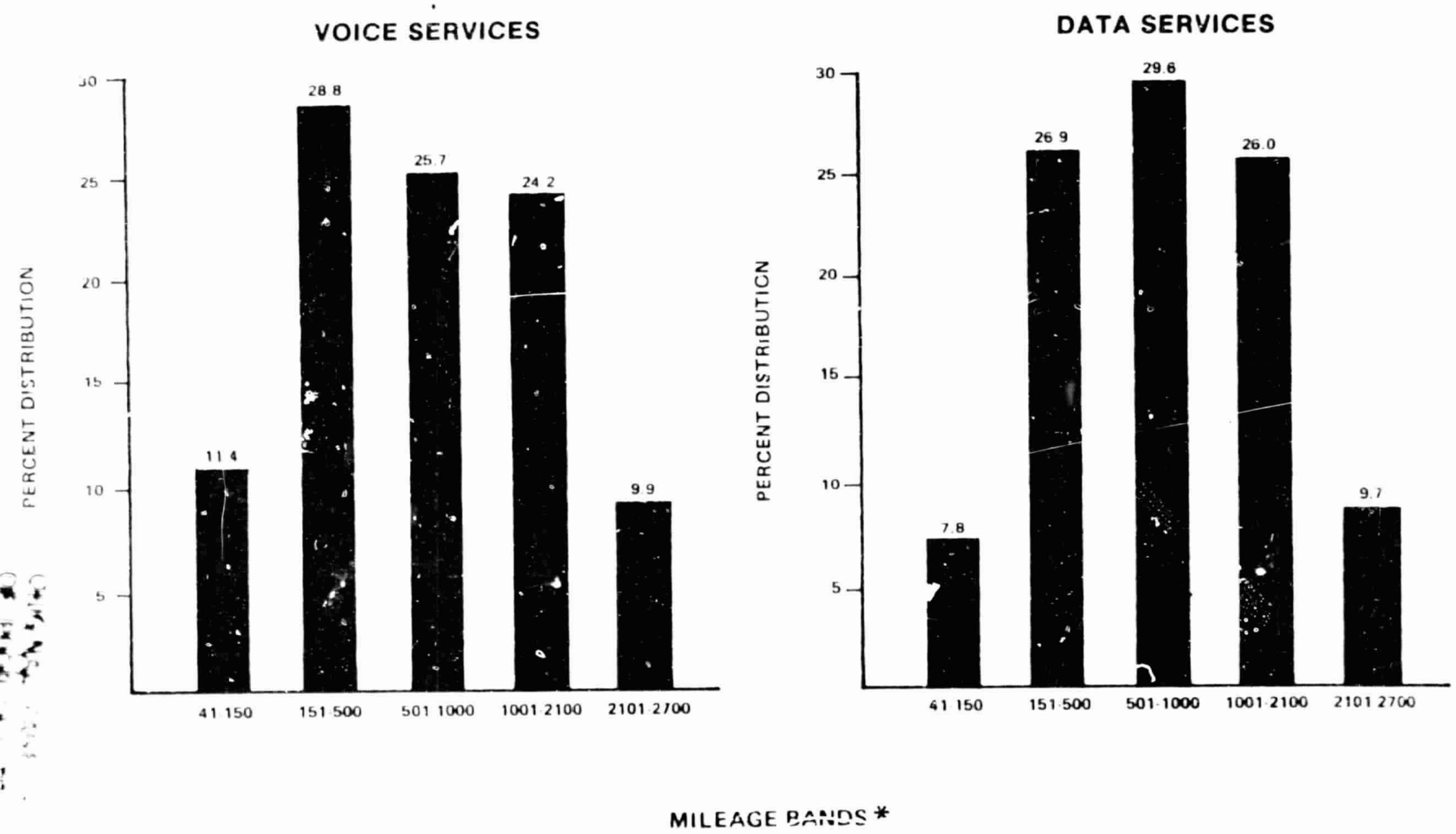
Table II-19 Mileage Band Categories

Mileage Band	(275 SMSA's) No. of Routes
0 - 40	163
41 - 150	1477
151 - 500	7716
501 - 1000	13340
1000 - 2100	12258
2101 - 2700	2721
	37675

Long haul data traffic/distance distributions by mileage band is also shown in Figure II-11. Traffic route densities for data services, Table II-21, were calculated in the same manner as for the voice traffic services. The bulk of the data traffic volume was almost evenly distributed among the third, fourth and fifth mileage bands. Data traffic density on a per route basis was highest in the second mileage band, although to a lesser degree than with voice traffic. The results of both the voice and data distributions were similar.

Table II-20 Traffic/Distance Distribution
Voice Services
Route Densities
(Long Haul)

Mileage Band	Percent Route Representation	Route Density 1980	1990	2000
0 - 40	NA		Not Applicable	
41 - 150	3.97	3.04	2.91	2.73
151 - 500	20.57	1.43	1.41	1.38
501 - 1000	35.56	.72	.73	.73
1001 - 2100	32.68	.73	.74	.77
2101 - 2700	7.25	1.[illegible]	1.37	1.41
	100.00%			



* 1-40 MILES NOT APPLICABLE

TRAFFIC DEMAND/DISTANCE DISTRIBUTION
1990

FIGURE II - 11

Table II-21 Traffic/Distance Distribution
Data Services
Route Densities
(Long Haul)

Mileage Band	Percent Route Representation	Route Density 1980	1990	2000
0 - 40	NA		Not Applicable	
41 - 150	3.97	1.99	1.99	1.99
151 - 500	20.57	1.32	1.31	1.32
501 - 1000	35.56	.84	.84	.84
1001 - 2100	32.68	.80	.80	.80
2101 - 2700	7.25	1.32	1.34	1.32
	100.00			

6.0 SIGNIFICANT CONCLUSIONS

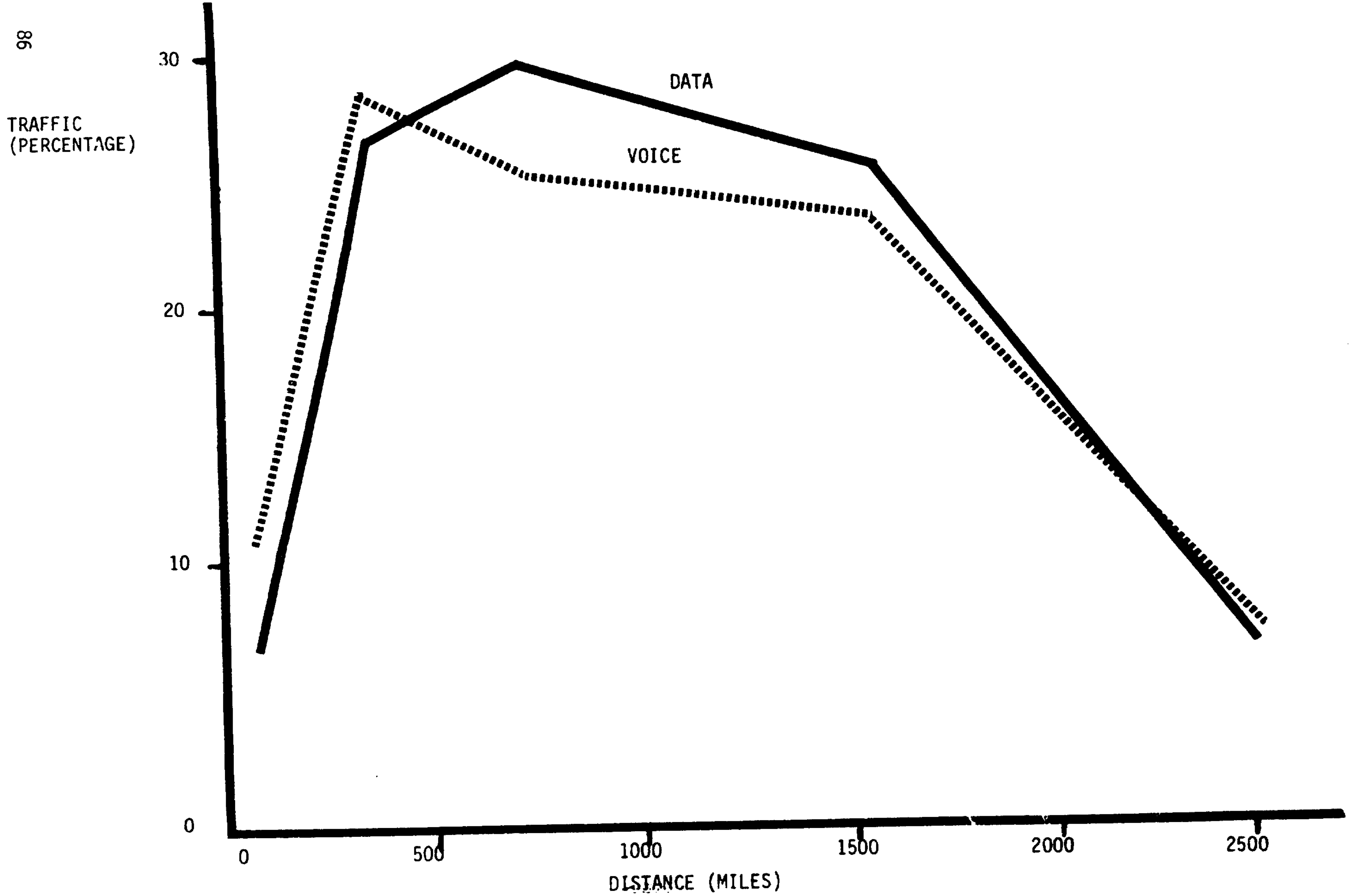
Voice traffic is most heavily concentrated in the 41-150 mileage band on an average route density basis. This result is caused by the geographical proximity of several of the largest SMSA's along the eastern corridor. In addition, there is an inverse relationship between distance and traffic which causes short routes to be more heavily used than long routes between similarly sized SMSA's. This relationship among shorter routes is independent of regional location and is quantified by the MDM. A similar line of reasoning applies to the third mileage band (151-500 miles). Groupings of large SMSA's which support this hypothesis are New York-Boston-Philadelphia-Baltimore-Washington, D.C. and Los Angeles-San Francisco-San Diego.

Coast-to-coast voice traffic, accommodated by the sixth band (2101-2700 miles) has a high average route density because of the cross-country traffic between the larger SMSA's identified along the east and west coasts. Although the two remaining mileage bands (501-1000 miles and 1001-2100 miles) have a large percentage of total traffic by virtue of the number of routes per mileage band, the average route density is significantly lower than that of the other bands. A frequency distribution of routes ranked by market value is greatly skewed toward those involving the smaller SMSA's. This affects the average route density calculations as a large proportion of such routes are found in the midwest, south and southwest areas where routes of 500 to 2100 miles predominate.

C-2

The distribution of long haul data traffic is similar to that of voice. Average route density is highest for the second mileage band (41-150 miles), though not as high as for the voice service category. The large number of routes between 501 miles and 2100 miles was reflected in the high percentage of traffic allocated to the two bands accommodating these distances. Traffic volume was greatest within the 501-1000 mile range because of the sheer quantity of routes and because data sites are usually geographically dispersed. The distribution among mileage bands is shown to be very stable between the years 1980 and 2000.

Figure II-12 is a graphical representation of the distribution of traffic over distance for the year 1990.



TRAFFIC/DISTANCE DISTRIBUTION - 1990

FIGURE II - 12

TASK 2.C TRAFFIC VOLUME AS A FUNCTION OF SMSA SIZE

1.0 STATEMENT OF WORK

The Contractor shall provide estimates of the magnitude of the traffic volume, by service category, as a function of city size. Representative cities, separated into five population sizes, from the largest down to 58,000 population, shall be examined, and the traffic volume typical of a city within each size category shall be determined as well as the number of cities within each size category.

2.0 INTRODUCTION

The purpose of this effort is to determine if a relationship exists between traffic volumes and population densities. The scope of this part of the study effort is based on 275 SMSA's aligned into five specific population categories.

The population database available in the Western Union Market Distribution Model (MDM) was used to distribute the 275 SMSA's into five population categories. Selection of the range for each of the five categories was based on the following:

- relatively equal distribution of population between categories
- natural breaks in the continuity of population between SMSA's
- an adequate coverage of the population range

Traffic volumes by service category for each of the SMSA's have been identified and statistical techniques within the MDM have been applied to establish a correlation between traffic volume and population for each service category.

The analysis did not include the video service category because a substantial portion of the video traffic is broadcast in nature (public, commercial and CATV networks) originating in a limited number of large cities and received throughout the entire United States. Also, since the number of wideband channels increases from 170 in 1980 to 450 by the year 2000, distribution of these forecasts among the 275 SMSA's would not be meaningful.

3.0 METHODOLOGY

The MDM population data base contains current information on 275 SMSA's representing approximately 72.4% of the U.S. population in the 48 contiguous states. Many SMSA's include more than one incorporated city inasmuch as smaller cities in many areas are frequently in a cluster surrounding or adjacent to a larger city.

It has been determined that evaluations of metropolitan areas rather than individual cities will provide more meaningful information because these areas normally share the same communication facilities. The 275 SMSA's were sorted in descending order by population, the total being divided into quintiles.

It is impossible to divide the 275 SMSA's into even population quintiles because of the degree of granularity in the largest SMSA's. Therefore, it was appropriate to find natural breaks (or discontinuities) in the population of adjoining SMSA's and separate the population categories at those points. For example, the fifth, sixth and seventh most populous SMSA's contained 4.3, 3.2 and 3.1 million people, respectively. Since the first quintile break would occur near this point, the break was made between the fifth and sixth SMSA's. This allowed a natural break where adjoining SMSA populations were 1.1 million (over 25%) apart.

Each category had a minimum/maximum range that produced five individual population groupings each with approximately 20% of the total SMSA population (157.3 million). Utilizing the MDM further, the percentage proportions of the market demand for voice and data traffic by SMSA were determined and subsequently assigned to the appropriate population quintile. This illustrated the relationship between SMSA population and market demand.

Weighting factors were developed for each quintile (by service category) to indicate the relative importance of market demand per unit population within the SMSA's. In mathematical terms the weighting factor was calculated by dividing the market demand percentages for each service category by its SMSA population percentage. It was hypothesized that market demand proportions less than 20% (within a quintile) showed a lack of correlation between market demand and SMSA populations. Conversely, market demand proportions higher than 20% indicated a direct correlation between traffic volumes and SMSA population sizes.

4.0 COMPUTER MODELLING

The listing of all SMSA's by population in descending order was accomplished using the MDM population data base. A printout made the manual separation of SMSA population into approximate quintiles easier because the natural breaks were more evident.

The SMSA market values, calculated by the MDM for Task 2.B were collected by population category to form the traffic demand volumes. For example, the top quintile included the five most populous SMSA's. All the traffic originating or terminating in these five SMSA's was collected in the first population category. Similarly, the second quintile traffic volumes were developed by summing the originating and terminating traffic in the subsequent 15 SMSA's. This internal process of the MDM algorithms determined the traffic volumes for voice and data for the year 1990. This allowed a comparison of SMSA size and market demand.

5.0 PRESENTATION OF RESULTS

Table II-22 presents the quintile distribution of SMSA population for 1990.

Table II-22 SMSA Population Density & Traffic Volume (1990)

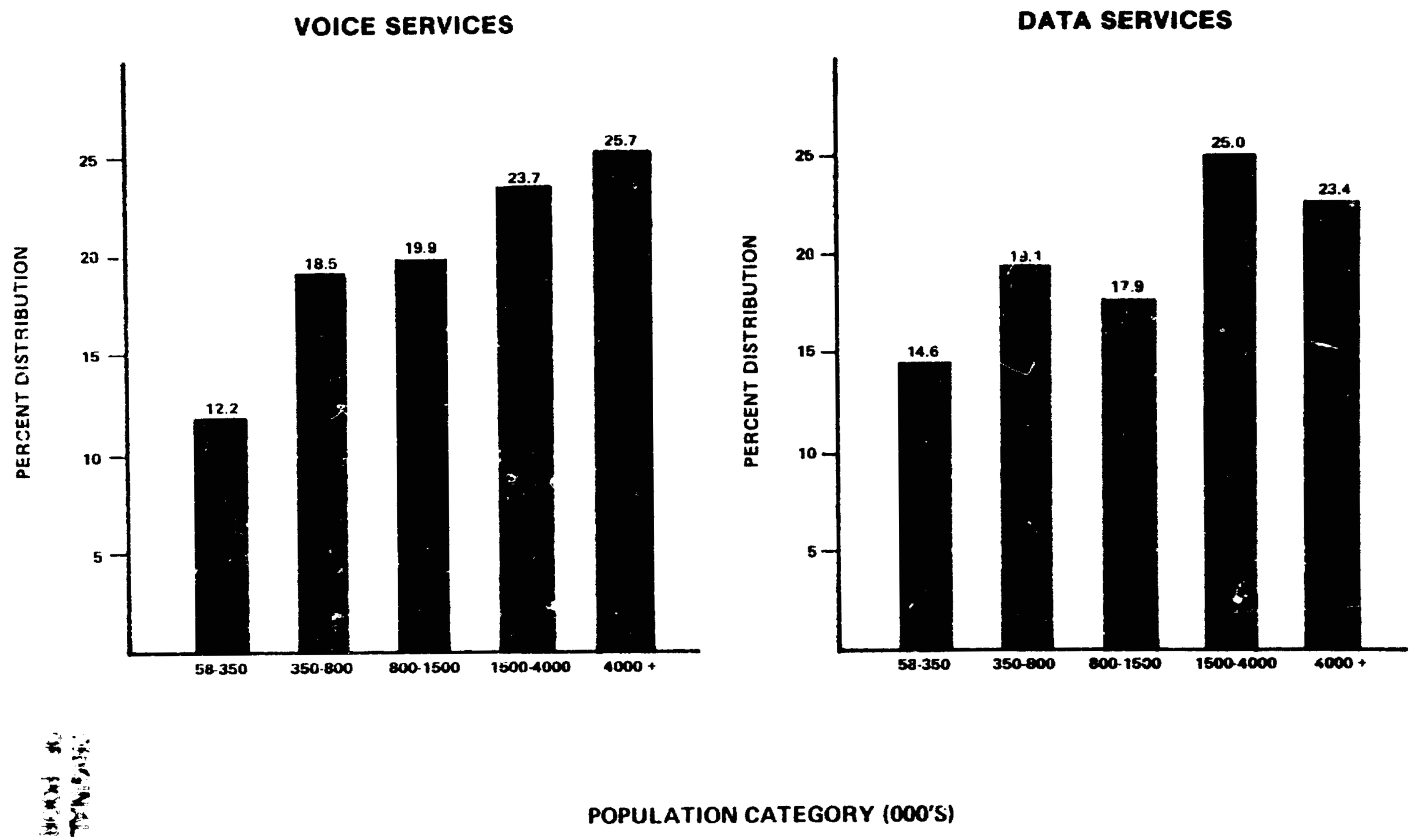
SMSA Population Category	SMSA's No.	SMSA's %	SMSA Population (Millions) Total	%	Mean
4 Million & Greater	5	1.8	32.8	20.8	6.56
1.5 - 4 Million	15	5.5	35.0	22.3	2.33
800,000-1.5 Million	25	9.1	28.4	18.1	1.14
350,000-800,000	61	22.2	31.3	19.9	.51
58,000-350,000	169	61.4	29.8	18.9	.18
Total	275	100.0	157.3	100.0	

Analysis of the first quintile shows that less than 2% of the SMSA's contains 20% of the total SMSA population, with the mean population being 6.56 million. The last quintile contains more than 60% of the SMSA's with the mean population being 180,000. Figure II-13 presents the market demand percentage distribution for voice and data services for 1990 by the five population categories.

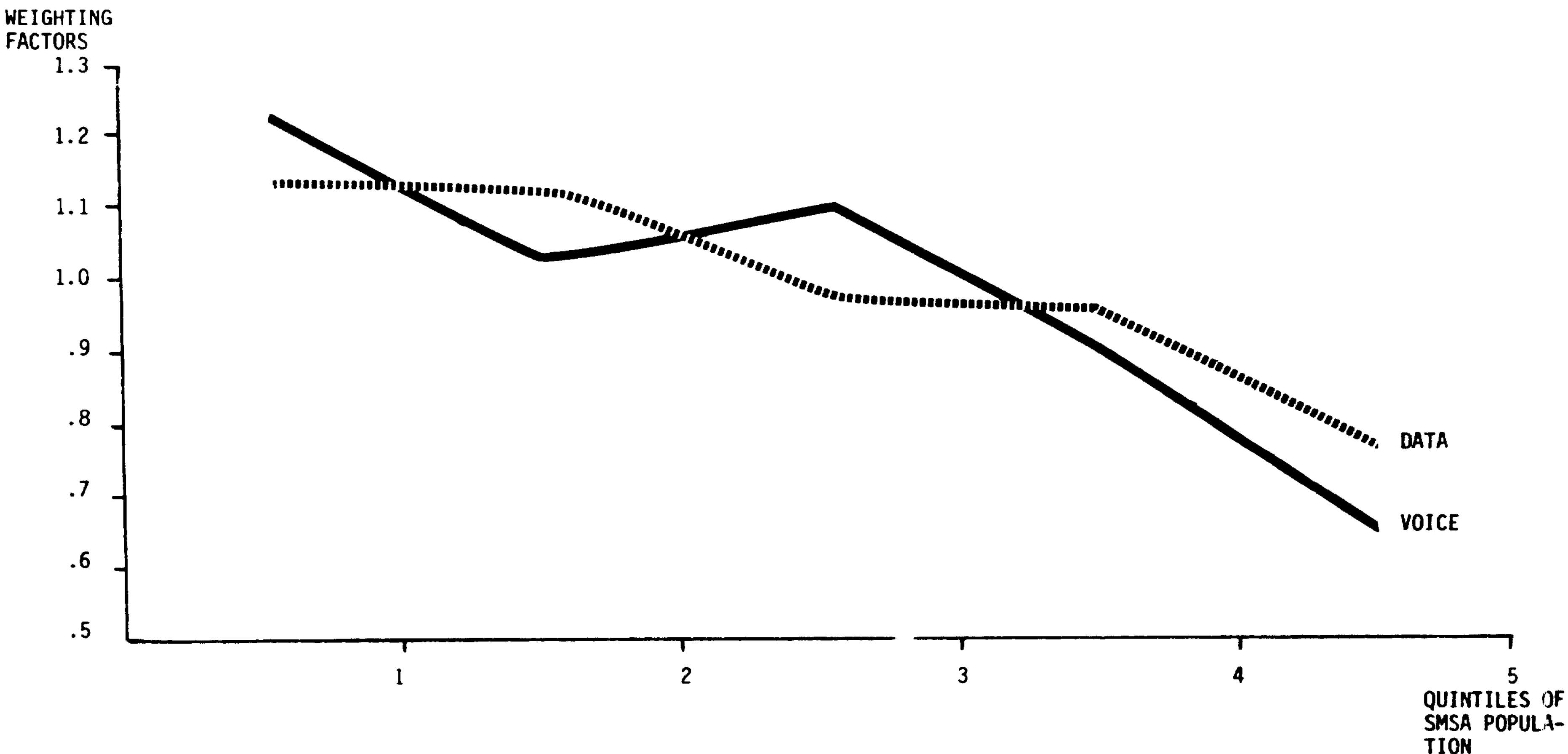
Weighting factors were developed by dividing the market demand percentages for voice and data by the SMSA population percentages, and are graphically represented by Figure II-14. These factors were used to analyze the relationship among voice and data services on a normalized basis, since the SMSA population percentages were not all exactly 20%.

6.0 SIGNIFICANT CONCLUSIONS

Analysis of the study results supports the contention that a direct correlation exists between the sophistication of the service under consideration and the size/population of the SMSA in that the more sophisticated services are concentrated in the largest SMSA's and that less sophisticated services more closely follow population distributions.



TRAFFIC DEMAND/POPULATION DENSITY
1990
FIGURE II - 13



SMSA POPULATION DENSITY AND TRAFFIC VOLUME WEIGHTINGS

FIGURE II - 14

The traffic distribution profiles for the voice and data service categories differ in detail due to characteristics associated with the individual applications which make up each category. With this in mind, the overall conclusion of market demand being positively correlated to SMSA population is explicitly in the graphical representation of Figure II-14. The most populous SMSA's (first quintile) are substantially overrepresented in market demand when related to population. In the voice service category, this overrepresentation is expressed by a weighting factor of 1.24. In the data service category, the weighting factor is 1.12. In the least populous SMSA's (fifth quintile) the underrepresentation in market demand is shown by weighting factors of 0.65 for voice and 0.77 for data.

Some of the variations in the general correlation of SMSA size and concentration of market demand between the voice and data service categories may be explained. In the first quintile, the voice weighting factor exceeds that shown for data. In the second quintile, the reverse is true. This may be due to the decentralization of computer facilities - one of the principal data category service profile criteria - away from primary commercial centers like New York and Chicago, toward secondary SMSA's such as Kansas City and Cincinnati. The second quintile data concentration is further emphasized by the presence of Washington, D.C., one of the most active data generating centers in the country.

The presence in the third quintile of comparatively large population SMSA's like Miami, Phoenix and New Orleans, which have a business orientation - rather than industrial and manufacturing, may explain the significantly higher voice weighting factor in that quintile than the second quintile. A business/commercial orientation in an SMSA suggests a usage profile directed more toward voice than data services.

A data service category caveat should be reiterated. Concentrations of data market demand indicated in this study refer to traffic and are not necessarily proportionately related to revenue. Some of the largest transfers of data traffic - such as that moving between computers - may contribute relatively little to total data transmission revenues, while other applications may generate substantial revenue without creating significant traffic. It is felt that if revenue were the principal criterion used in measuring the correlation between SMSA size and market demand, that the data service category would reflect an even greater positive correlation - similar to that shown for the voice service category.

TASK 2.D GEOGRAPHICAL DISTRIBUTION OF TRAFFIC VOLUMES

1.0 STATEMENT OF WORK

The Contractor shall construct a model of the geographical distribution of the estimated traffic volumes within the United States for 1980, 1990 and 2000. The results shall be displayed on a map of the U.S. showing the density of the traffic per unit area.

2.0 INTRODUCTION

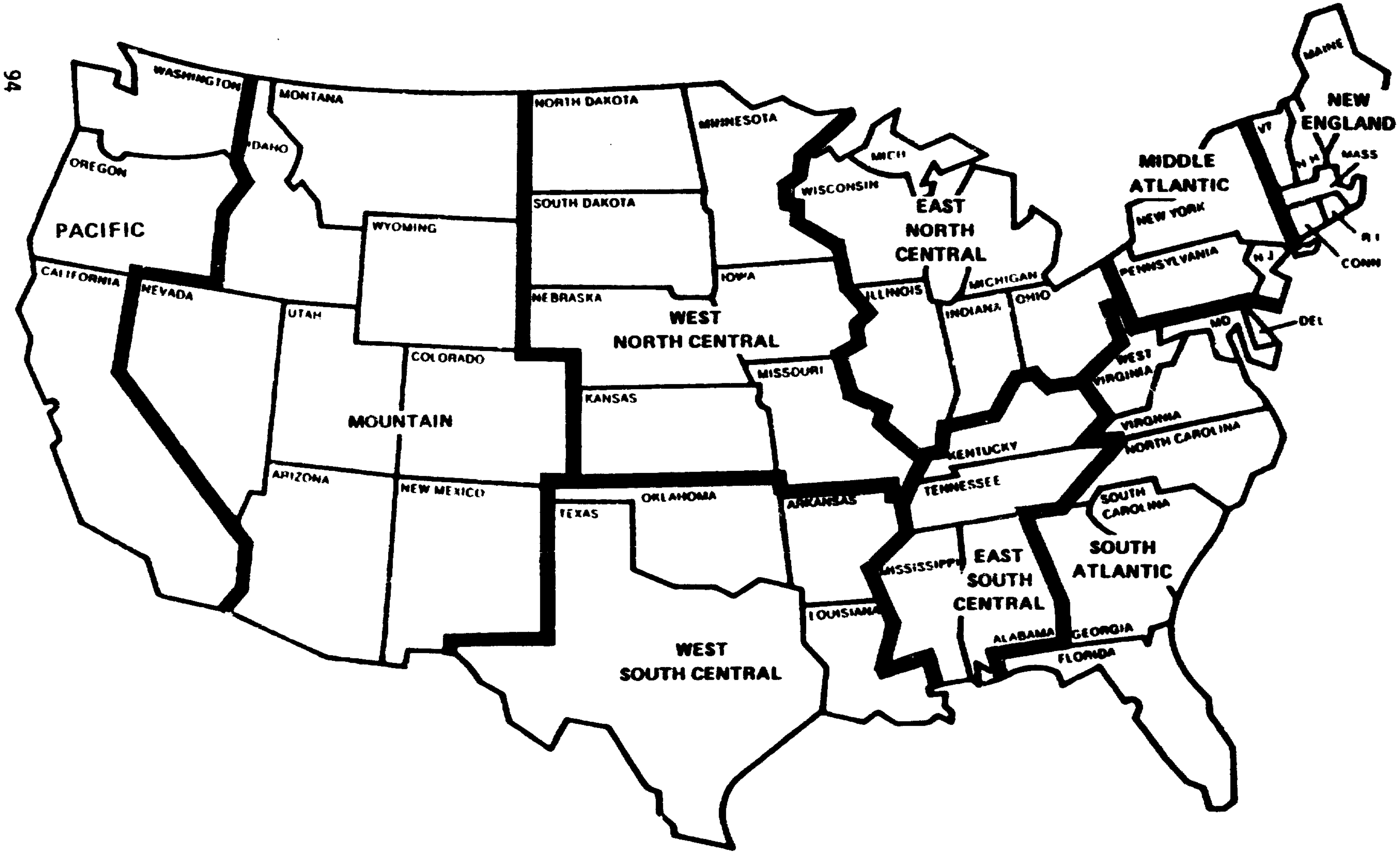
The purpose of Task 2.D was to show the relationship between geographical regions and long haul market demand for each of the three service categories - voice, video and data. The long haul forecasts were prepared as a part of Task 2.A and represent traffic transmitted at least 40 miles and originating or terminating in one of the 275 Standard Metropolitan Statistical Areas (SMSA's) located in the 48 contiguous United States.

The Market Distribution Model (MDM) has assigned market demand values to each of the 275 SMSA's for each of the service categories based on the usage profiles of each category. The MDM has calculated market values for each of the 37,675 routes connecting the 275 SMSA's using formulae internal to the model. By combining the route market values and the geographical areas, potential region/demand relationships can be interpreted for 1980, 1990 and 2000.

3.0 METHODOLOGY

Nine geographical areas were selected in conformance with Department of Commerce standards and as set forth in Rand McNally statistical work. The selected regions are shown below and in Figure II-15.

- New England
- Middle Atlantic
- South Atlantic
- East North Central
- West North Central
- East South Central



GEOGRAPHICAL TRAFFIC REGIONS

FIGURE II - 15

- West South Central
- Mountain
- Pacific

The 275 SMSA's were assigned to the appropriate regions. (SMSA's which crossed regional boundaries were assigned to the region where the greatest portion of its population resided.) The traffic market values for each route were distributed among the 275 SMSA's by the MDM. Appropriate weight was given to each region on the basis of traffic originating and terminating at each SMSA. This meant that the market demand for traffic which crossed regional boundaries was split between the applicable regions and that the market demand for traffic which both originated and terminated within a particular region was credited solely to that region. This process was applied to the long haul market demand associated for 1980, 1990 and 2000. Long haul traffic routes do not include those which are 40 miles in length or less. This removed 163 routes - less than one-half percent of the total number of routes - from consideration in the regional distribution of market demand. (See analysis for Task 2.C.)

4.0 COMPUTER MODELLING EFFORT

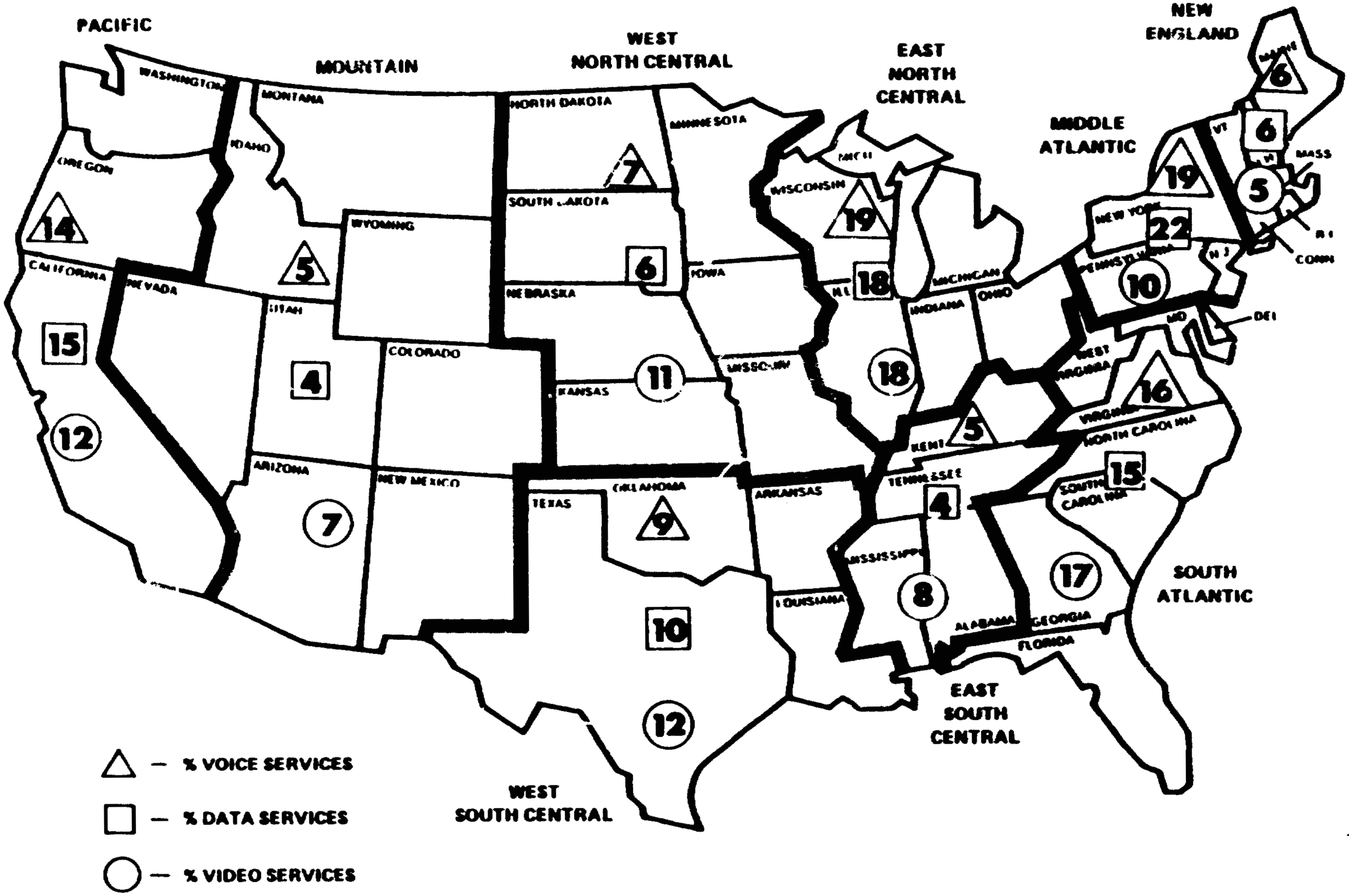
Task 2.D relied on the calculation and distribution of market demand as developed by the MDM. The operations and capabilities of the MDM have been outlined elsewhere in this document. The assignment of SMSA's to regions was done manually, assisted by computer generated printouts, and entered into the MDM data base for automatic recall and distribution. Generation of output reports, including summation of route market values by region and calculation of proportions, are routine operations of the MDM.

As an analytical aid, the 1978 populations of all SMSA's within each geographical region were tabulated and percentages calculated. These regional population proportions were used to compare the traffic volume distributions among the three service categories.

The comparison indicated that the video service category was the least affected by population density (correlation coefficient of .7053) substantiating the assertion that factors other than population directly affect video traffic.

5.0 PRESENTATION OF RESULTS

Figure II-16 presents the percentage geographical distribution of long haul traffic by the nine regions for the three service categories for the year 1990. The year 1990 has been selected as representative of the period under study. The principal causes for migration in market demand are the changing proportions of applications within each service category and the shift of population toward "sunbelt" geographical regions.



GEOGRAPHICAL DISTRIBUTION OF TRAFFIC BY REGION

1990

FIGURE II - 16

6.0 SIGNIFICANT CONCLUSIONS

Video traffic is more area oriented than voice and data traffic because of the broadcast nature of a large segment of this service category. As an example, each commercial video network has approximately 200 affiliates. The population served by each affiliate varies widely, depending on the population density of the area served. In New York City, 10 million people may be served by the local affiliate - while in Billings, Montana, the number served is only about 100,000.

The video traffic contains six regions greater than 10% (and none as high as 19%), while the voice and data traffic has a more unbalanced distribution - with entries for the heavily populated areas of the Middle Atlantic and East North Central near 20%. For example, in the most heavily populated Middle Atlantic area (20.5%), the voice and data traffic percentages were 19.1 and 21.9, respectively, while the video market demand was only 10.6%. In one of the least populated areas (East South Central - containing 4.6% of the total population), the voice and data percentages were 4.8 and 4.0, respectively, while video was much higher at 8.3%.

TASK 2.E SENSITIVITY OF SERVICE DEMAND TO VARIATIONS IN SERVICE COST

1.0 STATEMENT OF WORK

The Contractor shall provide estimates of the variation in service demand as a function of service costs for the years 1980, 1990 and 2000 with the range of service costs to be varied from one-half to two times the base service costs.

2.0 INTRODUCTION

One of the most influential factors affecting the pricing decision is the elasticity of demand. Elasticity of demand is a means of measuring the sensitivity of traffic volume to a change in the price of a communication service. Of course, a common carrier cannot set prices in a vacuum; information must be considered by which price elasticity and competitive reactions can be anticipated within reasonable limits. These facts call for some kind of historical, empirical analysis, as well as, an understanding of the regulatory tariffing requirement.

Due to the limited availability of research material and survey data on user buying influences, the scope of the price demand relationship is not statistically broad. However, source material has been gathered on several services, including:

- Telephone Voice (WATS/MTS)
- Record Message Services (Telex/TWX)
- Telegraph Services
- Digital Data Services (DDS)

Over the next 22 years, price is expected to play a greater influence in generating demand for communication services. This is due to improved technologies and new transmission facilities which are expected to lower the cost per bit of information transmitted.

2.A MEASURES OF ELASTICITY

Elasticity of demand refers to how volume-sensitive a service is to changes in its price. If the percentage change in traffic volume is greater than the percentage change in price, the demand for that service is said to be elastic. If it is a lesser percentage, it is inelastic.

For example, if a 4% decrease in price results in an 8% increase in traffic volume then the demand for that service is elastic, with an elasticity factor of 8/4 or 2. If a 10% decrease in price causes only a 5% increase in volume, the elasticity factor is 5/10 or one-half. In the formal economic definition, an elasticity factor of less than 1 represents inelastic demand.

The general form of a demand function for goods or services can also be expressed:

$X = f\ (Px, Pn, I, Z)$

where:

X = Quantity demanded per unit of time

Px = Price per unit of good x

Pn = Price of a related good or service

I = Consumer's Disposable Income

Z = Represents other relevant demand determinants.

The price elasticity of a good or service, X, is defined as the percent change in the quantity demanded of X related to a one percent change in the good or service's own price. The measurement of the elasticity coefficient is a three step process:

a. Compute the percent change in quantity demanded (sold)

b. Compute the percent change in price

c. Divide (a) by (b)

The average of the quantities and prices from two points can be used as the base figures.

2.B MARKETPLACE REALITIES

If price-volume sensitivity behaved predictably and consistently, lending itself to simple measurement, it would provide a specific factor in service pricing. However, the marketplace is filled with a variety of people who react to price changes with very different perceptions and actions. Unfortunately, the elasticity factor is not linear over time in any amount or in any direction.

Even if it were possible to predict the results of price changes, consideration must be given to a number of other market influences:

- Intensive advertising and selling efforts to promote an existing service may overcome adverse reactions to price increases.

- Competitors' responses will directly affect the volume response to service price changes.

- Users of communication services may have no alternative to a repriced higher service or it may be costly to switch.

- Finally, over time customers tend to get accustomed to the higher prices and resume service use at previous volume levels.

3.0 METHODOLOGY

3.A THE COMMUNICATIONS SERVICE ENVIRONMENT

In several past major communication user surveys, it was determined that service cost ranked near or at the top of criteria used in choosing specific services. What could not be determined was how different cost levels would influence the level of future service use. Certainly, the relative price of a service will influence its demand but several important circumstances, unique to the communication service business, will tend to reduce the elasticity of demand for service.

3.A.1 End Users of Services

The decision to procure communication services, whether voice, message or data, and the selection of a specific supplier is often in the hands of a company's communications, EDP or office manager. The selection of services may be based on price, but other factors such as service quality, availability, end-to-end service and customer service support all enter in his selection process. However, the communications manager is not the end user of the service; the people who work in the company are the individuals who create the demand.

These end users, management and clerical workers, usually have no perception of the cost of the communications facilities being used. Their need is to have the means (communication lines) to conduct their business. Therefore, changes in service price will have little or no impact on their volume of usage.

3.A.2 Relative Costs of Communications

Over 50% of all business communications revenues are generated by the top 500 U.S. companies. These firms have multi-billion dollar sales and equally large operating expenses. In a recent internal survey of more than 30 major companies, the average telecommunications costs were estimated at $32 million per year. On a base of operating costs in the multi-billion dollar range, telecommunications costs represent a rather small part of total corporate expenses.

The U.S. Department of Commerce reported that in 1977 total personal consumption expenditures on telephone and telegraph services of $22 billion represented just 1.7% of all personal consumption outlays by

the American people. Another way of viewing this cost of communications is that in 1977 every individual in this country had personal expenditures of $100 for communications services.

The relatively small proportion that communications represents of business or personal expenditure means that changes in cost of service will generally have a less significant impact on the level of usage.

3.A.3 The Regulatory Requirements

A request for an adjustment in service price, must be accompanied by a new tariff, supporting cost material and a three year projection of changes in revenues and demand. Assuming a price change is supportable, a minimum of three months and as much as one year or more may elapse before putting a price increase into effect.

The variances of price increases or decreases filed by carriers in the past have tended to fall in a range of 5 to 10%. Only very rarely are rate changes in the 20-25% areas implemented. Very often rate increases in one part of the service may be partially offset by decreases in a different element of the service charge.

3.A.4 Cross Elasticity of Services

The proliferation of new services and enhancements to existing ones has caused a relatively new market phenomenon: cross service switching. As user traffic volumes over a particular route increase, the tendency is to switch from a measured to a private line service to achieve cost savings. Services such as WATS, MTS, Execunet and SPRINT are very cross elastic in nature. The relative price comparisons between terrestrial versus satellite delivered services offer another example of service switching.

Thus, as changes in the price of one service occur, users have been able to take advantage of lower rates by cross switching to relatively similar services. This has tended to mitigate the effects of price changes over time.

3.B APPROACH

To try to determine the relative elasticity of demand for communication services, an extensive research effort was conducted. Discussions were held with two industry consultants, the Economics Division of the Federal Communications Commission, and market research consulting firms. This research produced some information but was not totally satisfactory.

Because of the necessity for having supporting tariff material, some internal information existed in the area of elasticity of telegraph and record message services. This data, while somewhat dated, provides part of the basis for elasticity considerations by service.

A review of other carrier supportive tariff material revealed that AT&T, as part of Docket 18128, has filed material on WATS voice service and its Dataphone Digital Service.

A review of economics journals, consultant reports, and research articles, produced some general data on price elasticity but little that could be used for specific service elasticity.

3.C SOURCE DATA METHODOLOGIES

3.C.1 Voice Services

Within the voice services category, research in the area of price elasticity was done for Wide Area Telephone Service by AT&T. The methodology involved a thorough user sample study using the Bell customer population and historical customer billing records of a representative sample of 1200 customers with usage characteristics similar to the entire voice market. Detailed WATS data for the 1200 customers was obtained, including number of WATS and MTS lines, number of hours of usage, number of messages per line, WATS locations called, etc.

A number of models were created to simulate shift factors for different rate steps. Customer data bases were segregated into market segments receiving a range of price increases or decreases in the WATS rates. The steps ranged from something greater than a 50% increase to decreases in excess of 50%. This was accomplished by repricing each customer service group under the current and new WATS rates, and calculating the anticipated percent change in demand. The price elasticity weights were then applied to these market segments to estimate shifts in demand.

3.C.2 Telegraph Service

The Office of Telecommunications Policy of the U.S. Department of Commerce produced a study which performed a time series analysis of the demand for telecommunications services. The study examined the long term correlation between such factors as disposable income, business activity levels and other economic measures with volumes of telegraph messages.

The standard demand models developed by O.T.P. researchers yielded unsatisfactory results in the sense that few of the correlations were found to be statistically significant. The evidence that was obtained pointed to the conclusion that demand elasticities of telegraphic communication services with respect to disposable income and business profit levels are negative and quite inelastic. This seems compatible, however, with the declining volume of telegrams over the historical period studied.

3.C.3 Digital Data Services

As part of AT&T's justification for rate changes and overall rate of return studies, information was developed as to its digital data services, on a private line basis, at transmission speeds ranging from

2.4 bps to 56 Kbps. The elasticity analysis for Dataphone Digital Service (DDS) had to be done on a theoretical basis because of the relatively few years the service has been available.

Essentially, a demand model was constructed, based on four alternative pricing levels. The first pricing level for intercity charges was considered the base price. The subsequent three higher price levels, in increments of +5%, +15% and +20%, were evaluated in terms of projected service cancellations or switches to cross elastic services. The ratio of changes in the number of subscriber lines at post-rate change levels was compared to the base number of subscriber lines and represented the elasticity of DDS service demand.

3.C.4 Record Message Service - TWX

An internal Western Union study was conducted to determine to what degree TWX subscriber shrinkage increases with the magnitude of a rate change. Overall, a 1.1% increase in average TWX subscriber rates was tested. The methodology involved building a data base file of customer accounts in advance of the proposed rate change filing. Comparison was made of that file with a similar one at the time of the rate filing to eliminate interim disconnects. Finally, a comparison was made, six months after the rate filing became effective, with the database of subscribers at the time of the filing, to determine shrinkage, after deducting for average expected disconnects.

The data base contained data for September 1976 on over 38,000 accounts. The rate filing was made on December 1, 1977 and the second data base was assembled as of December 31, 1977. The third data base was prepared as of June 30, 1978, six months later and compared with the previous data base. The number of disconnects between the two periods thus represented the "normal" disconnects which occur over time and those additional disconnects which could be attributed to the rate filing of December 1, 1977.

It should be noted that many individual rate elements for TWX service were changed resulting in a range of rate increases for all customers. This range varied from a 10% decrease to as much as a 55% rate increase. The heaviest concentration (40% of the total) was, however, in the 0 to 5% rate increase range. Thus, a range of rate changes in subscriber levels could be determined.

4.0 <u>PRESENTATION OF RESULTS</u>

4.A VOICE SERVICE - WATS

The AT&T analysis of Inward WATS assumed the service to be virtually non-cross elastic with other communications services. It was established, based on the previously outlined methodology, that the Inward WATS service was relatively inelastic, as shown in Table II-23.

This translates into a price elasticity coefficient ranging from .12 to .40. Thus, for example a 20% decrease in WATS voice service price is projected to yield a 2.5% increase in market demand. A similar price elasticity study prepared by the O.T.P. indicated a price inelasticity ranging between 0.1 and 0.3.

4.B TELEGRAPH SERVICE

Telegraph service appears to be quite price inelastic. It was found that a competing service, such as telephone service prices, has no effect on telegraph demand.

The range of price elasticity coefficients for telegraph service revealed by the O.T.P. study was .25 to .75 which yielded the conclusion that the service had an inelastic demand to changed price levels.

4.C DIGITAL DATA SERVICE

AT&T DDS service filings and supporting market research studies indicate that this service is price elastic with coefficients ranging from 1.0 to 2.5.

TABLE II - 23 Inward WATS Elasticity

PRICE CHANGE	MARKET DEMAND SHIFT
- 50%	1.125
- 40 to - 50%	1.100
- 30 to - 40%	1.075
- 20 to - 30%	1.050
- 10 to - 20%	1.025
0 to - 10%	1.000
0 to + 10%	1.000
+ 10 to + 20%	.950
+ 20 to + 30%	.900
+ 30 to + 40%	.850
+ 40 to + 50%	.800

The reasons for the elasticity of digital data service include:

- The availability of competing substitutable data transmission services in an analog form, along with the smaller installed base of higher speed terminals.
- The rapidly growing use of digital transmission may be directly related to its costs.
- The assumption by AT&T that a 96 city digital network would make facilities more available and the DDS service more attractive.

4.D RECORD MESSAGE SERVICE - TWX

In the case of the teletypewriter exchange service (TWX) offered by Western Union, the shrinkage study indicates a relatively price inelastic service. As FigureII-17 shows, the range in elasticity coefficients was .07 to .13. Except for the subscribers who received a (+) or (-) 1% rate change, in every other rate change category the coefficient was less than unity (even) and indicated an insensitivity to price level swings. This would indicate that factors other than price have determined the long term attractiveness of TWX service.

For example, given a 65-70% rate increase in service at the high end, the TWX model generated an estimated percent of cancellations of about 6%. At the low end, for a rate increase of only 1-2%, subscriber cancellations were estimated at about 1.4%.

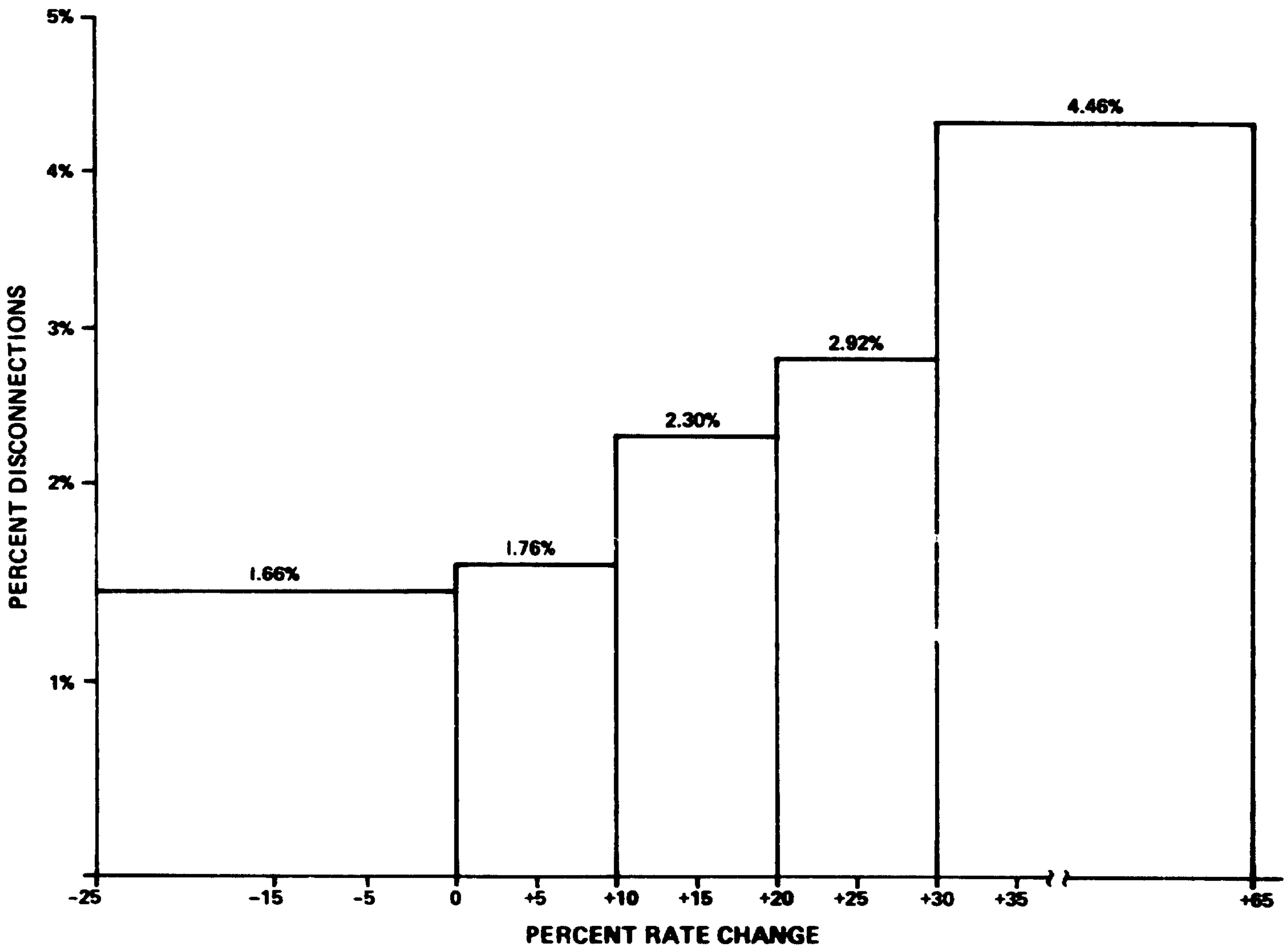
5.0 SIGNIFICANT CONCLUSIONS

Several significant conclusions may be drawn from the research results previously analyzed. While not totally conclusive due to lack of confirming tests or market research they appear to point in the same general direction.

1. Price increases in communication services cause greater and greater reactions as the magnitude of the rate change grows, but the reverse is not true in the case where price decreases become larger.

2. Service quality and availability are other important criteria in determining service usage and cancellations.

3. In general, business users are believed to be more insensitive to service price changes than the public sector as a whole, especially for long distance services.



TWX SUBSCRIBER ELASTICITY ANALYSIS
JANUARY — JUNE 30, 1978

FIGURE II - 17

4. Users of new, innovative services tend to be more sensitive to price increases than users of long established services.

5. The demand for local communication service for both households and businesses and long-distance service for business appears to be independent of price.

As mentioned earlier, no information could be gathered about long term trends in price elasticity and no reasonable means within the scope of the contract enabled Western Union to predict elasticity coefficients in the 1980 - 2000 period.

SECTION 3

TASK 3A USER CATEGORIES

1.0 STATEMENT OF WORK

The contractor shall provide forecasts of traffic volume for each service type and for the years 1980, 1990 and 2000 by user category. The user categories are defined as follows: government, institutions, business and private individuals.

2.0 INTRODUCTION

Having estimated the long haul telecommunications demand, it was necessary to determine which sectors in the U.S. economy are potential users of telecommunications and the projected level of demand for each. Four user categories were appropriate for this determination: Business, Government, Institutions and Private. Industry economic data, operating characteristics and telecommunications demand were analyzed on an invididual basis in order to determine trends in each sector. The results formed the basis for forecasting the demand for voice, data and video services by user categories for the three forecast years (1980, 1990 and 2000).

3.0 METHODOLOGY

This task involved defining the composition of each user category and segregating the net long haul traffic volume forecast generated in Task 2 among the four designated user categories.

Many documents researched in the literature survey were reviewed to identify data on the demand for telecommunications services by user industry sector presented in terms of either traffic volumes or dollar expenditures. Further efforts were made to obtain such data from various industry and trade associations, government agencies and various market research firms involved in telecommunications market studies. The research formed the basis for the preparation of forecasts of communications expenditures by industry sector. Users expenditures on usage of telecommunications services or on transmission facilities (henceforth called "transmission expenditures") were utilized to calculate their relative size in the total traffic demand for that service type. Since the task required the forecasting of users' long haul traffic for each service, the transmission expenditures of each industry sector were factored appropriately to reflect just the long haul portion in the total. The factoring was based upon the results of various user surveys previously done by Western Union and also the qualified judgements of professionals working in major market research organizations as well as in the respective industry sectors.

The traffic volume forecasts for voice, data and video service categories for 1980, 1990 and 2000, as generated in response to Task 2, provided the demand forecasts for certain user categories such as the private user category in the case of voice and the government user category in the case of data. The demand for the above user categories was extracted from the total for that service type and the remaining traffic volume was distributed among the others in proportion to their net long haul transmission expenditures. The process of forecasting users' future demand involved calculation of average annual growth rates (AAGR's) for the forecast period for certain user categories. These AAGR's were based primarily on their average annual increases in transmission expenditures over the past few years.

A different methodology was used in forecasting the demand for video services by user category. Each video application was analyzed separately in view of its "effective" end users and the demand for each end user was separately estimated.

Finally, the percentage shares of user categories in the total demand for each service type, were calculated and several conclusions were drawn.

3.A USER CATEGORY DEFINITION

The telecommunications user population was grouped into fourteen industrial and one non-industrial (residential users) sector utilizing the Standard Industry Classification (SIC) system. These industry sectors were further grouped into the four user categories based upon the primary function of each in the U.S. economy and also its operating characteristics (Table III-1).

Table III-1 User Category Definition

User Category	Industry Sector	SIC Code
Business	Manufacturing (Discrete and Process)	20-39
	Wholesale Distribution	50-51
	Retail Distribution	52-59
	Finance and Banking	60-67
	Insurance	63-64
	Transportation	40-47
	Utilities	48-49
	Professional Business Service	73-89
	Other (Miscellaneous Businesses)	01-89
Government	Federal	91-97, 43
	State and Local	91-97
Institution	Education	82
	Health Care	80
	Other Membership Organizations	83, 86
*Private	U.S. Population (Households) not residing in institutions	-

*Non-Industrial sector

3.B USER SHARE OF TELECOMMUNICATIONS DEMAND

Many documents and articles researched in the literature survey were reviewed in an effort to identify data on demand for telecommunications by user industry sector. Further efforts were made to obtain such information from the Federal Communications Commission (FCC), the U.S. Department of Commerce, industry associations such as Telecommunications Association (TCA), International Communications Associations (ICA), American Bankers Association (ABA) and the American Hospitals Association (AHA). Various telecommunications market research firms were contacted or their studies reviewed to determine the telecommunications demand by user industry sector. Some of these were Arthur D. Little, Future Systems Inc., International Resource Development, International Data Corp., Quantum Science, Inc., and Frost and Sullivan.

The literature survey disclosed a few studies which provide analyses and forecasts of telecommunications expenditures by user industry sector. The primary source of information were published studies of Quantum Science Corporation. These documents were reviewed with their consultant staff; particularly their survey approaches, sample size, sources of input data and methodology used in forecasting.

As a preliminary step, the economic data on each user industry in the above studies were examined. Forecasts of users' voice communications expenditures included their expenditures on message communications. Message services are subsets of data services, therefore, these service expenditures were subtracted from the voice forecasts and added to users' data communications expenditures.

Table III-2 displays the net 1978 transmission expenditures for voice and data services by user industry sector within each user category.

Demand for the private user category (residential users) was separately estimated in Task 2A - "Telecommunications Service Demand." The demand for video services by user category was also separately developed and will be discussed later in paragraph 3.D - "Traffic Volume Forecasts by User Category."

3.C USER SHARE OF LONG HAUL COMMUNICATIONS

This subtask utilized several in-house market research study conclusions which were confirmed in subsequent telephone conversations with major industry leaders. Special attention was paid to the derivation of overall short haul (less than 40 miles) and long haul (greater than 40 miles) proportions in the total transmission expenditures for voice and data services, by industry sector within each user category. Subsequent paragraphs describe the rationale behind the derivation of those proportions.

Table III-2

Voice and Data Services
Users Total Transmission Expenditures ($ Millions)
1978

	Voice		Data	
	Transmission Expenditures	% Distribution	Transmission Expenditures	% Distribution
Business				
Manufacturing	$ 5090	36.9	$ 1453	30.4
Wholesale Distribution	163	1.2	176	3.7
Retail Distribution	547	4.0	371	7.8
Finance/Banking	1033	7.5	579	12.1
Insurance	862	6.3	302	6.3
Transportation	781	5.7	336	7.0
Utilities	378	2.7	149	3.1
Professional Business Services	1091	7.9	328	6.9
Other	724	5.2	131	2.7
Subtotal	$ 10669	77.4	$ 3825	80.0
Government				
Federal	1389	10.1	456	9.5
State and Local	916	6.6	367	7.7
Subtotal	$ 2305	16.7	$ 823	17.2
Institutions				
Education	249	1.8	39	.8
Health Care	496	3.6	83	1.7
Others	61	0.5	10	.3
Subtotal	$ 806	5.9	$ 132	2.8
Total	$ 13780	100	$ 4780	100

Note: The demand for private user category was separately estimated in Task 2A.

Table III-3 Distribution of Short Haul and Long Haul Traffic by Service Category - Manufacturing

Service	Short Haul	Long Haul	Total
Voice	30%	70%	100%
Data	15%	85%	100%

The manufacturing/industrial sector, comprised of discrete and process manufacturing industries, plays an important role in the determination of traffic distribution. The largest manufacturing corporations (Fortune 1000 Industrials) generate 90% of the total revenues from this sector and employs more than 83 percent of this sector's total employment. Therefore, it is this segment which establishes norms for the entire manufacturing sector. The geographical coverage of almost all of these thousand industrial corporations encompasses the entire U.S., with plants, sales offices and regional and corporate headquarters scattered throughout the country. This creates a significant need for long haul voice and data communications between these office locations (Table III-3).

This sector is gradually heading towards implementing the concept of distributed data processing, by employing improved capabilities of minicomputer, high speed data terminals, facsimile equipment, communicating word processors, and advanced application-oriented communications services such as packet switching data networks, wideband terrestrial as well as satellite facilities.

Table III-4 Distribution of Short Haul and Long Haul Traffic by Service Category - Wholesale

Service	Short Haul	Long Haul	Total
Voice	65%	35%	100%
Data	25%	75%	100%

Large wholesalers, frequently have sales offices and showrooms in central trading areas with several warehouses strategically located. These sales offices have a significant voice communications need with their local retailers and comparatively little voice communications among sales offices, warehouses and headquarters. Long haul is a relatively smaller proportion of their total voice communications. In wholesale distribution, facsimile is commonly used for intra-company inventory data, shipment data, advertising copy layout and prints, vouchers and credit, accounting records, payroll records, contracts, quotes, purchase order, etc. Since maintenance of updated merchandise inventory records is a critical task in their operations it involves proportionately greater long haul data transmission (Table III-4).

Table III-5 Distribution of Short and Long Haul Traffic by Service Category - Retail

Service	Short Haul	Long Haul	Total
Voice	70%	30%	100%
Data	75%	25%	100%

Research efforts reveal that the top 50 Fortune retailers (i.e., approximately .005% of the total retailers) represent 19% of the total employment and about 20% of the total sales revenues generated in this sector. These 50 retailers contribute about 20% of the sector's total transmission expenditures from stores scattered nationwide, either under the same corporate name or under different brand names, all of which display a significant need for long haul communications.

The remaining 99.995% of the retail firms account for the remaining 80% of the sector's total transmission expenditures. This sector, if analyzed further, would probably show that the next 10% of the retail firms contribute an additional 40% to the sector's total transmission expenditure. The essence of the above conclusions is that a large proportion of retail firms are fairly small in size and operate in a limited geographical area and require little long haul communication (Table III-5).

Table III-6 Distribution of Short and Long Haul Traffic by Service Category - Finance/Banking

Service	Short Haul	Long Haul	Total
Voice	40%	60%	100%
Data	50%	50%	100%

The banking industry is a local and regional one with the exception of a few large banks. Both savings and commercial banks operate within a limited territory due to stringent federal and state laws. Banks by virtue of their very functions have a significant need for voice and data communications. Over 90 million transactions are made every day, a large proportion of which is short haul traffic. Besides depository, loan, and trust services, a few large banks do offer certain consulting-oriented services such as published econometric data and their analyses, and various credit services involving interbank transactions. The latter is a small portion of banks' total data traffic.

On the other hand, stock brokerage firms and exchange houses, as well as other financial institutions in this sector, like credit agencies, are more geographically dispersed than banking and therefore have significant data, text and voice communications requirements, particularly long haul. There were 494 member brokers in the U.S. in 1975, having 3210 offices located in almost all metropolitan areas and employing 34,643 registered representatives. The telephone system is an integral part of the operation in this industry and this subsector accounts for a significantly large proportion of this sector's total long haul traffic (Table III-6).

Table III-7 Distribution of Short and Long Haul Traffic by Service Category Insurance

Service	Short Haul	Long Haul	Total
Voice	50%	50%	100%
Data	15%	85%	100%

Only about 1% of the insurance companies (Fortune's top 50 insurance companies) represent about 30% of the total premium revenues generated and employ about 30% of the total employment in this sector. In addition, these 50 companies make up about 29% of the sector's total transmission expenditures.

Headquarters of large insurance companies are found in major metropolitan areas such as New York, Chicago, Los Angeles, Boston and uniquely, Hartford. Geographic decentralization of operations is an increasing trend within the large companies, but actuarial and financial activities remain highly centralized. In this sector, both short haul and long haul voice traffic are equally significant.

The insurance business, by its nature, requires data communications for the setting up of customer policy records, the processing of premium installments, database inquiry/response, the batch processing of regional sales office records and receipts and so on. Due to wider geographical coverage in this sector most of the data communications is long haul in nature. The large data flow from regional and local offices to headquarters and the high volume of data lines between computer centers for the exchanging of information and data bases justifies the 85% long haul data traffic in this sector (Table III-7).

Table III-8 Distribution of Short and Long Haul Traffic by Service Category - Transportation

Service	Short Haul	Long Haul	Total
Voice	50%	50%	100%
Data	15%	85%	100%

Only about 1% of the transportation companies (Fortune's 50 biggest transportation companies) represents about 66% of the total sales, employs about 37% of the total employment in this sector and represents about 51% of the sector's total transmission expenditures. These large companies provide wide geographical coverage with sales offices and independent travel agencies. Their operational characteristics are very similar to those of insurance companies and may be paraphrased with the statement - "the telephone system is an integral part of their operation." Centralized data base management systems in this industry generate significantly large inquiry/response type of data communications (Table III-8).

Table III-9 Distribution of Short and Long Haul Traffic by Service Category - Utilities

Service	Short Haul	Long Haul	Total
Voice	75%	25%	100%
Data	75%	25%	100%

Characteristically, because of the tight regulations that govern their operation, utility companies operate in a well defined territory rather than on a nation-wide basis. Therefore, most of this sector's traffic is short haul in nature with limited long haul traffic (voice as well as data), generated to communicate with construction contractors, engineering consultants, and equipment and fuel suppliers. In addition, there is a limited need for facsimile transmission for supplying technical data and blue prints, etc. to their vendors (Table III-9).

Table III-10 Distribution of Short and Long Haul Traffic by Service Category - Professional Business Services

Service	Short Haul	Long Haul	Total
Voice	40%	60%	100%
Data	40%	60%	100%

Most major Accounting, Advertising, Management Consulting, Architectural and Computer Service firms have their facilities and offices in major U.S. cities. This calls for a greater communications need (voice as well as data) among their branches as well as between the branches and headquarters. As an exception, the Computer Service industry has an additional need to link their computer centers, which are strategically located within the U.S., and simultaneously extend their services to local users via long haul transmission facilities leased from common carriers (Table III-10).

Table III-11 Distribution of Short and Long Haul Traffic By Service Category - "Other Businesses"

Service	Short Haul	Long Haul	Total
Voice	70%	30%	100%
Data	60%	40%	100%

This sector is comprised of diverse and miscellaneous industries such as Construction, Mining, Fishery, Real Estate, Hotels/Motels, which could not be combined with the preceding sectors. With the exception of Hotel/Motel chains, this sector requires very little long haul communications. Hotels/ Motels chains, due to their wide geographical dispersion have a greater long haul communications need to link their individual units with the headquarters and a central computer center. Most other industries within this sector are geographically limited in scope and therefore have limited long haul communications needs (Tables III-11).

Table III-12 Distribution of Short and Long Haul Traffic By Service Category - Health Care and Education

Service	Short Haul	Long Haul	Total
Voice	55%	45%	100%
Data	95%	5%	100%

The Health Care and Education sectors have functional similarities, in that they provide services to communities residing in localized areas. Individuals in these sectors have limited long haul communications requirements. The students residing in college and university dorms and patients in hospitals generate the vast majority of long haul voice traffic.

At present, there is little need in these sectors for long haul data transmission. Most of the data processing functions are performed locally. In view of recent and anticipated developments in this sector, such as shared library access via a regional or nationwide network; shared communications network in the case of health care (mainly large hospitals); and the development of various electronic mail service systems, the long haul data traffic in this sector may increase in the near future (Table III-12).

Table III-13 Distribution of Short and Long Haul Traffic by Service Category - Federal Government

Service	Short Haul	Long Haul	Total
Voice	30%	70%	100%
Data	15%	85%	100%

The federal government sector has heavy nationwide and worldwide communications traffic requirements. Currently, the federal government is the largest user of ATT's Telpak offering. As the federal government departments and agencies have a large number of office locations (over 11,000) dispersed widely throughout the U.S., there exists significant need for long haul communications (Table III-13).

In Task 3B (Relative Size of Each User) it was identified that the Department of Defense alone makes up 23.5% of the sector's total budget outlay, employs 48.5% of the sector's total employment and spends over 23% of the total dollars spent on usage of telecommunication services. Furthermore, six major departments: Department of Defense; Health, Education and Welfare; Treasury; Veterans Administration; Agriculture; and Transportation, make up over 60% of the sector's total transmission expenditures.

Table III-14 Distribution of Short and Long Haul Traffic by Service Category - State Government

Service	Short Haul	Long Haul	Total
Voice	30%	70%	100%
Data	45%	55%	100%

More often than not, the state capital is greater than 40 miles from major population centers within the state, and office locations of state departments and agencies like those of the federal government are dispersed widely within the state. In addition, on administrative and legislative levels, state governments have a need to communicate with various federal departments and agencies, particularly in Washington, D.C. For these reasons, state governments generate significant long haul voice traffic.

The data processing functions in most of the state departments/ agencies are performed locally and only limited long haul data transmission is required to exercise central control (Table III-14).

Table III-15 Distribution of Short and Long Haul Traffic by Service Category - Local Government

Service	Short Haul	Long Haul	Total
Voice	70%	30%	100%
Data	90%	10%	100%

Less than 250 of the largest city governments have potential long haul communications requirements. This is a factor of their size, concentration of businesses and residential population in their cities. These city governments often employ foreign exchange lines and intrastate as well as interstate WATS lines for their long haul communications. More than 80% of the local governments units are smaller in size and the extent of their operations is limited. They have relatively little need for long haul traffic transmission (Table III-15).

Based upon the long haul proportions assessed above for each user industry sector, long haul transmission expenditures of each sector within each user category were estimated (Tables III-16 and III-17). No such estimates were developed for the Private User Category since Task 2A (traffic volume forecasts) separately identifies the private user sector's long haul traffic demand for voice and data service categories. Furthermore, no such estimates were necessary for the video service category since a different methodology was used in estimating the demand for video services by user category.

3.D TRAFFIC VOLUME FORECASTS BY USER CATEGORY

The following describes the approach used in the development of users' traffic volumes for each service type for the years 1980, 1990 and 2000.

Table III-16

Voice Services
Users Long Haul Transmission Expenditures ($ Millions)

BUSINESS	1978 TRANSMISSION EXPENDITURES	% LONG HAUL (GREATER THAN 40 MILES)	1978 NET LONG HAUL TRANSMISSION EXPENDITURES	1978 % DISTRIBUTION
Manufacturing	5090	70	3563	45.0
Wholesale Distribution	163	35	57	0.8
Retail Distribution	547	30	164	2.1
Finance/Banking	1033	60	620	7.8
Insurance	862	50	431	5.4
Transportation	781	50	391	4.9
Utilities	378	25	95	1.2
Professional Business Services	1091	60	654	8.3
Other	724	30	217	2.7
SUBTOTAL	10669	58% overall	6192	78.2
GOVERNMENT				
Federal	1389	70	972	12.3
State	298	70	209	2.6
Local	618	30	185	2.3
SUBTOTAL	2305	59.3 overall	1366	17.2
INSTITUTIONS				
Education	249	45	112	1.4
Health Care	496	45	223	2.8
Others	61	50	31	.4
SUBTOTAL	806	45.4 overall	366	4.6
TOTAL	13780	57.5% overall	7924	100

Table III-17

Data Services
Users Long Haul Transmission Expenditures ($ Millions)

BUSINESS	1978 TRANSMISSION EXPENDITURES	% LONG HAUL (GREATER THAN 40 MILES)	1978 NET LONG HAUL TRANSMISSION EXPENDITURES	DISTRIBUTION
Manufacturing	1453	85	1235	[illegible].3
Wholesale Distribution	176	75	132	[illegible].3
Retail Distribution	371	25	93	3.[illegible]
Finance/Banking	579	50	290	9.5
Insurance	302	85	257	[illegible]
Transportation	336	85	286	[illegible]
Utilities	149	25	37	1.3
Professional Business Services	328	60	197	6.4
Other	131	40	52	1.7
SUBTOTAL	3825	67.4% overall	2579	84.2
GOVERNMENT				
Federal	456	85	388	12.7
State	119	55	65	2.1
Local	248	10	25	0.8
SUBTOTAL	823	58.1% overall	478	15.6
INSTITUTIONS				
Education	39	5	2	.07
Health Care	83	5	4	.13
Others	10	2	0	0
SUBTOTAL	132	4.5% overall	6	.20
TOTAL	4780	64.1% overall	3063	100

3.D.1 VOICE

Figure III-1 presents the process of distributing the net long haul voice traffic volumes (as developed in Task 2A) among the four user categories. Since the residential users (i.e., private user category) use only the AT&T provided Message Telecommunications Service (MTS) for their long haul voice communications, the MTS-Public portions of the Task 2A forecasts were extracted from the total (Table III-18).

Table III-18 Voice Services

Net Long Haul Traffic Volumes
(Half Voice Circuits, Thousands)

	1978	1980	1990	2000
Total	1754	2095	5320	13805
Less: MTS (Public)	-584	-708	-1771	-4043
	1170	1387	3549	9762

Previous analyses showed that the Federal and State Governments together make up over 86% of the total government long haul voice transmission expenditures and these sectors derive significant benefits from various discounted voice services such as Telpak, WATS, Foreign Exchange Lines and Private Lines. The Federal sector alone is the largest user of the AT&T provided Telpak offering which is a bulk-discount private line service and costs 30-40% less than the cost of an individual private line for the same distance.

In the case of the Institutions Category, hospitals and institutions of higher educations must be relatively large to warrant significant long haul traffic. The survey of typical users in these categories revealed that the hospitals and universities make good use of various intra and interstate discounted voice services such as WATS and Foreign Exchange lines. These services offer 15-20% savings over the regular MTS services often used by small businesses (approximately 97% of the business users). Given the above facts, "traffic equivalent" factors were applied to the net long haul transmission expenditures of the Business, Government and Institutions user categories. The term "traffic equivalent" is defined as the ratio of a category's traffic volume per dollar of transmission expenditure to that of the business category.

TRAFFIC VOLUME BY USER CATEGORY
VOICE SERVICES

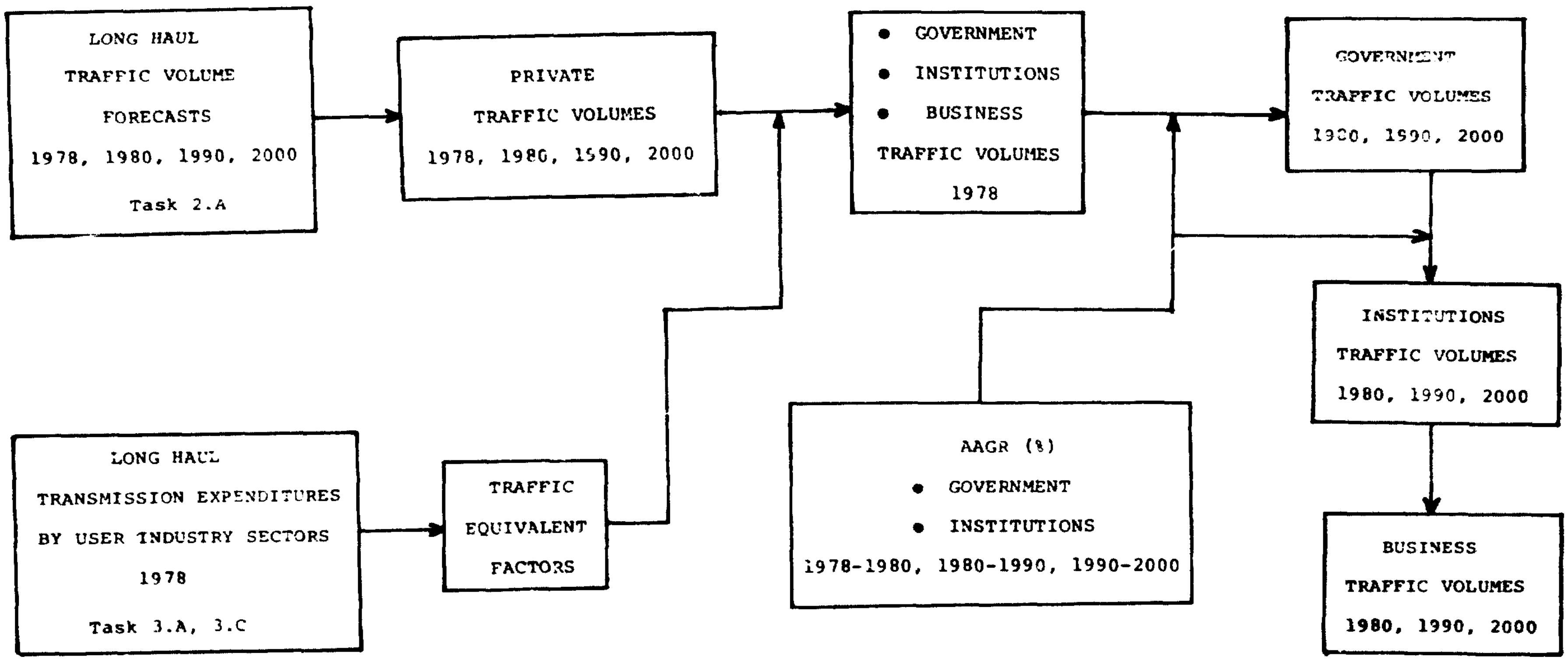


FIGURE III-1

The 1978 combined long haul traffic volume of Business, Government and Institutions as determined in the previous step was then distributed among them in proportion to their net traffic equivalent long haul transmission expenditures (Table III-19).

Table III-19 Voice Services - 1978 Net Long Haul Traffic Volumes and Transmission Expenditures

User	1978 Net Long Haul Transmission Expenditures ($ Million)	Traffic Equivalent Factor	1978 Net (T/E) Long Haul Transmission Expenditures ($ Million)	% Distribution	*1978 Net Long Haul Traffic Volumes
Business	6192	1.0	6192	75.0	877
Government	1366	1.2	1639	19.9	233
Institutions	366	1.15	421	5.1	60
Total	7924		8252	100	1170

*(Half voice circuits, thousands)

The process of forecasting traffic volumes for the above three categories for the years, 1980, 1990 and 2000 involved estimation of average annual growth rates (AAGR) for Governmental as well as Institutional voice traffic. In the case of the Government category, separate average annual growth rates were developed for Federal and State/Local sectors. During the period 1976 to 1978, average annual growth rates for transmission expenditures were approximately 9.9% for the federal sector and 11.3% for the state/local sector. Since the Government sector is a heavy user of private lines and their cost has not increased significantly in the past 3 to 4 years, inflation rates of 1% for Federal and 2% for State/Local in acquiring those voice services were assumed. After adjusting for inflation, the average annual growth rate during 1976-78 for the Federal sector at constant 1975 dollars was 8.9% and about 9.3% for State/Local. Furthermore, since the Government sector as a whole, is relatively mature in its demand for voice services, it was assumed that both annual growth rates will taper off to 5% in the year 2000. The above growth rates were then plotted and the averages for the period 1978-80, 1980-1990,and 1990-2000 were calculated.

In order to apply the separate AAGR's, the forecast of 1978 Government traffic volume was distributed among the Federal and State/Local sectors in proportion to their net long haul transmission expenditures (Table III-20).

Table III-20 Forecast of 1978 Net Long Haul Traffic Volumes for Federal and State/Local Governments

User Sector	1978 Net Long Haul Transmission Expenditures ($ Million)	% Distribution	1978 Net Long Haul Traffic Volumes (Half Circuits)
Federal	972	71.16	166
State/Local	394	28.84	67
Total	1356	100	233

The same approach was used in estimating and projecting the average annual growth rates for the Institutions category. Voice transmission expenditures in this category have been growing at an AAGR of 10.43% over the past 3 to 4 years. Assuming an inflation rate of 3%, the AAGR at constant 1975 dollars would be 7.43%. In view of the fact that the hospitals and colleges are considering the construction of shared nationwide networks for their long haul communications, the annual growth rate could reasonably be assumed to be 6% in the year 2000. Plotting the above annual growth rate, the averages for the period 1978-80, 1980-1990 and 1990-2000 were calculated.

Applying the above average annual growth rates to the 1978 traffic volume forecasts of the Federal and State/Local sectors as well as the Institutions category respectively yielded their demand forecasts for the years 1980, 1990 and 2000 (Table III-21).

Table III-21 - Net Long Haul Traffic Average Annual Growth Rates Government and Institutions

(Half Voice Circuits, Thousands)

User	1978	% AAGR 1978-80	1980	% AAGR 1980-1990	1990	% AAGR 1990-2000	2000
Federal	166	8.5%	195	7.5%	402	5.9%	713
State/Local	67	9.1%	80	8.0%	173	6.0%	310
Total Gov't	233		275		575		1023
Institutions	60	7.2%	69	6.75%	133	6.25%	244

Finally subtracting the Government, Institutions and Private User traffic volumes from the total yielded the forecasts of Business demand for voice services (Table III-22).

Table III-22 - Business Users Net Long Haul Traffic

(Half Voice Circuits, Thousands)

	1980	1990	2000
Total	2095	5320	13805
Less: Private	-708	-1771	-4043
Less: Government	-275	- 575	-1023
Less: Institutions	- 69	- 133	- 244
Business	1043	2841	8495

Table III-23 summarizes the percentage distribution of the net long haul traffic volume forecasts by user category for voice services.

Table III-23 - Projected Voice Services Traffic Volume by User Category

(Half-Voice Circuits)
(Thousands)

	1980		1990		2000	
User Category	Circuits	%	Circuits	%	Circuits	%
Business	1043	49.8	2841	53.4	8495	61.5
Government	275	13.1	575	10.8	1023	7.4
Institutions	69	3.3	133	2.5	244	1.8
Private	708	33.8	1771	33.3	4043	29.3
Total	2095	100.0	5320	100.0	13805	100.0

3.D.2 DATA

Figure III-2 provides the approach used in the process of segregating the net long haul data traffic forecasts (as developed in Task 2A) by the user categories. The Government long haul data traffic requirements were estimated separately by analyzing the Government Telpak voice and wideband networks, existing in-service satellite wideband circuits, existing medium and low speed data circuits, as well as their projected wideband requirements. The process involved an in-depth review of a five volume study performed by the Western Union Government Systems Division. The Private user category demand for data communications services was also separately estimated.

Subtracting the Government and Private user demand for data communications services from the total long haul data traffic volume forecasts yielded the data traffic volumes for the Business and Institutions categories (Table III-24).

Table III-24 Data Services
Net Long Haul Traffic Volumes
(Terabits/Year)

	1978	1980	1990	2000
Total	816.9	1078.5	6957.3	27553.6
Less: Government	-174.1	-222.9	-1111.1	-3694.7
Less: Private	- .09	- .09	- 40.6	- 49.2
Business and Institutions	642.7	855.5	5805.6	23809.7

The next step was to distribute the 1978 net long haul data traffic volume of Business plus Institutions among them in proportion to their net "traffic equivalent" long haul transmission expenditures (Table III-25). (Note: The term "traffic equivalent" is defined in Section 3.D.1 of Task 3.A.)

TRAFFIC VOLUME FORECASTS BY USER CATEGORY
DATA SERVICES

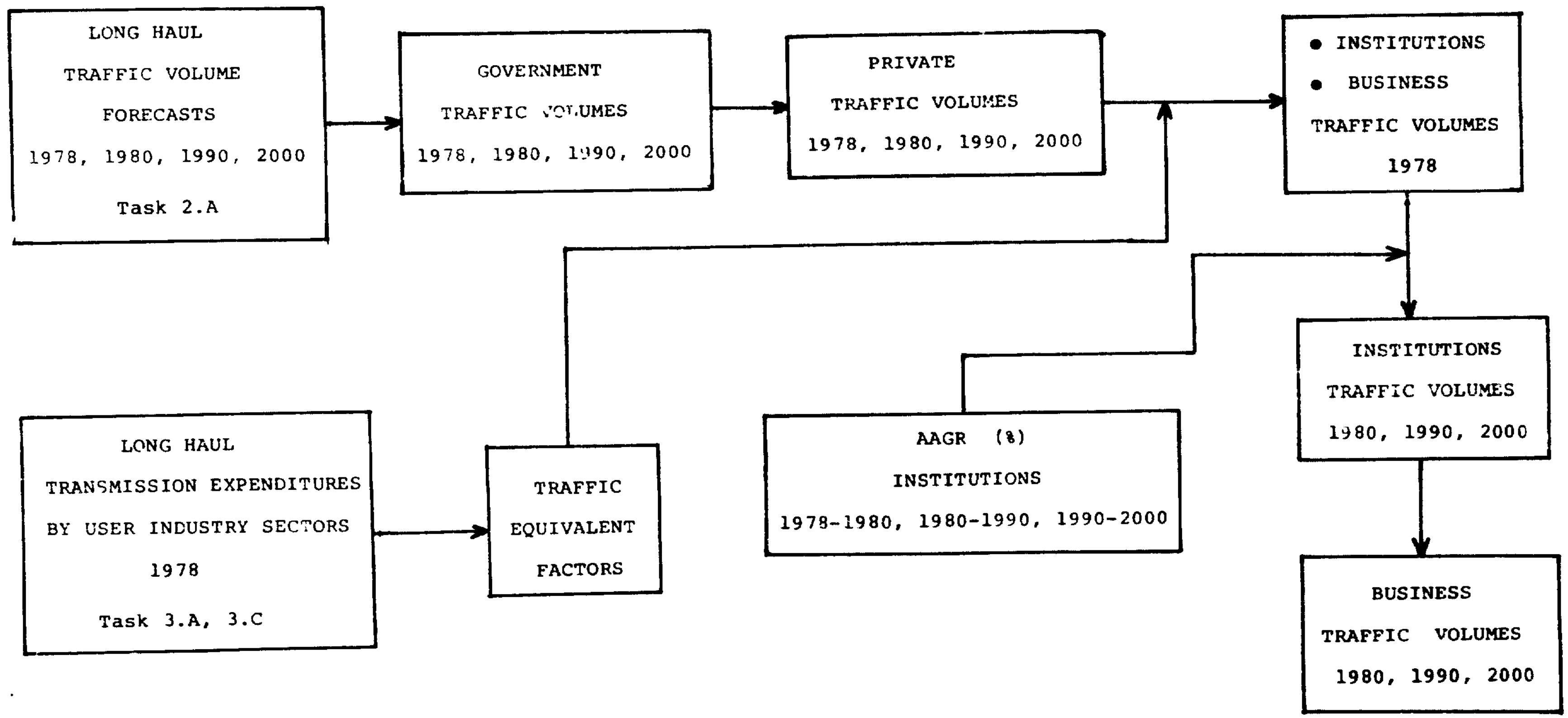


FIGURE III-2

Table III-25 - Data Services
1978 Net Long Haul Traffic Volumes and Transmission Expenditures

User	1978 Net Long Haul Transmission Expenditures ($ Million)	Traffic Equivalent Factor	1978 Net T/E Long Haul Transmission Expenditures ($ Million)	% Dist.	1978 Net Long Haul Data Traffic Volume (Terabits/Yr.)
Business	2579	1.0	2579	99.7	640.8
Institutions	6	1.15	7	.3	1.9
Total	2585		2586	100	642.7

Forecasting data traffic volumes for the Business and Institutions categories for the years 1980, 1990 and 2000 required estimation of their average annual growth rates (AAGR's). Since the Institutions category is comprised of fewer major sectors (i.e., Health Care and Education) than the Business Category, it was decided to estimate the AAGR's of the Institutions long haul data traffic. The average annual growth rate of the Institutions (Health Care and Education) during 1976-1978 was approximately 14%. Assuming an annual inflation rate of 3% in this category for acquiring facilities and data communications services, the effective AAGR at constant 1975 dollars would be 11%. But, in view of the current developments in the Health Care and Education sectors (particularly major hospitals and institutions of higher educations) with regard to shared nationwide networks for their long haul communications needs such as shared libraries, shared medical databases, etc., the AAGR of 14% for this category seemed reasonable. Since the long haul data communications in this category is expected to grow rapidly and at a significant rate during the next ten years, the annual growth of 12% in the year 2000 can reasonably be assumed. Plotting the above growth rates, the intermediate averages for the period 1978-1980, 1980-1990 and 1990-2000 were calculated.

Applying these AAGR's to the 1978 data traffic volume for the Institutions category provided the forecasts of traffic volumes for this category for the years 1980, 1990 and 2000. Added to these forecasts were the estimates of Institutions demand for electronic mail services. Task 2A projects that electronic mail services will experience rapid growth in the mid-1980's and Institutions will have about 8% of the total electronic mail traffic in the years 1990 and 2000. Subtracting the Institutions demand from the totals of Business plus Institutions (as estimated in the previous step) yielded the Business data traffic volumes for the years 1980, 1990 and 2000.

The traffic volume forecasts of each of the four user categories for data services are summarized in the Table III-26.

Table III-26 Net Long Haul Traffic Volumes
Data Services
(Terabits/Yr.)

User Category	1980 Terabits/Yr	1980 %	1990 Terabits/Yr	1990 %	2000 Terabits/Yr	2000 %
Business	853	79.1	5714.6	82.1	23674.9	85.9
Government	222.9	20.7	1111.1	16.0	3694.7	13.4
Institutions	2.5	.2	91.0	1.3	134.8	.5
Private	.1	0	40.6	.6	49.2	.2
Total	1078.5	100	6957.3	100	27553.6	100

3.D.3 VIDEO

Traffic volume forecasts by user category for video services required defining the "effective" end user for each service applicant. For example, although it seems indisputable that "homes" are the principal end users of video transmission services, it can be argued that "businesses" are the "effective" end users in most cases. It is the home audience that watches "All in the Family", but it is a business, CBS that decides to secure the video transmission services to distribute "All in the Family". In the eventuality of a program change by the home viewer, however devoted he may be to Archie Bunker, will have to set his dial on another channel if he wants to watch television. Therefore it is a business that is the "effective" end user.

The process of distributing the long haul video traffic volume forecasts (as developed in Task 2A) by user category required analysis of each service application of video transmission and assignment of its traffic to one or more "effective" end users as applicable. These users were classified as Business, Government, Institutions or Private based upon their primary function in the U.S. economy. For example, commercial networks such as ABC, CBS, and NBC which are profit oriented organizations were classified as businesses, the Public Broadcasting Service (PBS) and other educational networks which provide a public service on a non-profit basis, were classified as Institutions.

The process of forecasting video demand by user category involved the estimation of each "effective" end user's current usage of video services and assessing his future demand for those services. Trade articles and in-house resources were reviewed as a part of this process of estimation and assessment. Table III-27 shows the video traffic volumes expressed as "satellite equivalent" wideband channels by user category.

Table III-27 Net Long Haul Traffic Volumes
Video Services
(Wideband Channels)

User Category	1980 Channels	1980 %	1990 Channels	1990 %	2000 Channels	2000 %
Business	125.6	71.4	218.0	74.3	346	75.6
Government	10.0	5.7	21.4	7.3	37.9	8.3
Institutions	40.4	22.9	54.2	18.4	64.5	14.1
Private	0	0	0	0	9.5	2.0
Total	176	100	293.6	100	457.9	100

4.0 SIGNIFICANT CONCLUSIONS

The traffic volume forecasts by user category for each service type were analyzed and average annual growth rates for each user's traffic as well as the total traffic for each service were calculated (Table III-28). The major conclusions drawn from this task are:

a. The overall long haul traffic demand for voice services is expected to grow at an average annual growth rate of 10% over the next 20 years. This is attributed to the continued steady growth of long distance calls in the Business and Private user categories. The Government and Institutions are fairly mature user categories for long haul voice communications. Furthermore, the reduction in the number of federal and state government locations over the past few years, the efforts to minimize government budget deficits, and the rising operating costs of institutions will have a significant impact on these users telephone patterns. Business and Private users will continue to be the dominant market for voice communications services, accounting for 80-90% of the total voice traffic.

Table III-28

Average Annual Growth Rates (%)
Of User Traffic Volumes

User Category	1980 - 1990 Voice	1980 - 1990 Data	1980 - 1990 Video	1990 - 2000 Voice	1990 - 2000 Data	1990 - 2000 Video	1980 - 2000 Voice	1980 - 2000 Data	1980 - 2000 Video
Business	10.5	20.9	5.7	11.6	15.3	4.7	11.1	18.1	5.2
Government	7.7	17.4	7.9	5.9	12.8	5.9	6.8	15.1	6.9
Institutions	6.8	43.3*	3.0	6.3	4.0	1.8	6.5	22.1	2.4
Private	9.6	82.3*	-	8.6	2.0	-	9.1	36.3	-
Overall Total	9.8	20.5	5.3	10.0	14.8	4.5	9.9	17.6	4.9

*Due to rapid growth in public usage of electronic mail services in 1985-1990 time frame.

b. Business will be the dominant user category for data communications services with its share increasing from 79% in 1980 to about 86% in the year 2000. The demand for data communications in the Business category will grow at an average annual growth rate of 18% over the next two decades.

c. Business demand for video services will grow at a modest average annual rate of 5% during the forecast period. By the year 2000 the three major networks, ABC, CBS and NBC, are expected to convert their terrestrial networks to satellite networks. The majority of new business interests will be providers of programming to the CATV community and for teleconferencing applications.

d. Compared to state and local governments, the federal sector, being significantly larger in size and having more centralized control of its communications requirements, will be the first one to take the advantage of various innovative telecommunications systems and service offerings.

TASK 3.B RELATIVE SIZE OF EACH USER

1.0 STATEMENT OF WORK

The Contractor shall estimate the communications market size by service type, for the years 1980, 1990 and 2000, of typical users within each user category defined in Task 3.A.

2.0 INTRODUCTION

It is generally known that a relatively small percentage of users generate the majority of all long haul telecommunications traffic. Therefore, it was necessary to measure the potential demand of that major segment within the requirements of the entire user category.

The broad characteristics of typical users in those major segments become particularly significant when forecasting demand by category of user and by type of service. Their requirements will be instrumental in the final calculations of 18/30 GHz market demand forecasts over the next two decades.

3.0 METHODOLOGY

Determination of the major segment of the user population within each user category required compilation of lists of major users. The Fortune Double 500/50 directory provided a list of over 1300 of the largest businesses in seven important industry sectors. A federal government department and agency list was obtained from the U.S. Government Manual. A list of major city/local governments was compiled using the Statistical Abstract published by the U.S. Department of Commerce, Government Finances and City Government Finances and Employment. The Education Directory and American Hospital Association Guide provided lists of institutions of higher education and major hospitals respectively.

Although developing a quintile distribution of user population in each user category by traffic volume seemed adequate for this task (as per the task proposal), it was not practical to do so because of the following constraints:

- The industry sectors within a user category differ significantly from each other in terms of their operating characteristics, their primary function in the U.S. economy and their geographical coverage. These three factors have a substantial impact on a sector's ability to employ and derive benefits from various price-volume and price-distance sensitive service offerings. Each sector, due to its unique communications requirements, uses the same service offering for different applications in different proportions. For example, a Telpak (AT&T bulk discount offering of private lines) user might opt to use this service one hundred percent for his voice communications needs whereas another user might use Telpak solely for data communications, and a third user might use it for both, in a proportion that varies over time.

- Previous survey of users indicated that users within the same industry sector have different utilization patterns and needs in their use of a communications service. For example, one user may want to transmit batch data during peak business hours whereas another user may choose to delay transmission until non-peak hours in an effort to derive cost savings.

The essence of the above discussion is that the task of developing quintiles in terms of traffic volume involves a very complex process and requires taking in account several factors impacting users' price-traffic ratios by service category (different ratios for voice, data and video services). Estimation of these ratios for the four user categories requires an in-depth analysis of users within each industry sector. It also requires a large survey of users, one that was not permissible or contemplated in the study scope proposed.

As a result, it was determined that the quintile distributions and typical users communications requirements be expressed in terms of dollar expenditures.

Appropriate algorithms were developed to model the process of distributing the transmission expenditures among the users in each list. Having estimated the transmission expenditures of major users, a quintile distribution of the user population in each user category was developed by ranking the users by their estimated transmission expenditures. Users with median expenditures, classified as "typical users", were selected from the quintiles of each user category and a survey of these typical users provided detailed information on their requirements for each service type through the year 2000. The numeric values of demographic variables relating to operating characteristics and transmission expenditures of user populations in each quintile or a group of quintiles were calculated, and used as norms for each of the four user categories. The results of the task efforts were then analyzed and relevant conclusions drawn.

3.A USER POPULATION

Determining the user population in each of the four user categories was an important task element in the development of quintile distributions. Several source documents such as the Fortune Double 500 directory, the U.S. Government Manual, Statistical Abstract, etc., were reviewed and information on major users as well as the total user population within each category was gathered. The following briefly provides the size of the user population and also the major users within each user category.

3.A.1 Business

The 1978 Fortune Double 500 directory provided listings of the 1000 largest industrial corporations and the 50 largest corporations in retail, finance, banking, insurance, transportation and utility sectors. A sample of the top professional business services was selected based on information received from their industry associations. The combined lists provided a sample of 1309 corporations out of a total of over 3 million companies (partnerships and corporations) in this category.

3.A.2 Government

A total of 84 major departments and agencies were identified. The budget and employment data on 50 states and 62,437 local government units which included 48 major cities and 343 additional cities with a population of more than 50,000, were gathered and utilized in the development of government quintiles.

3.A.3 Institutions

Hospitals and institutions of higher education were the major users in the health care industry and education sectors which in turn were the major sectors in the Institution category as a whole. Lists of hospitals and institutions of higher education were compiled and a random sample of these two groups was utilized in the development of their separate quintiles. A random sample of 147 colleges out of a total of 3,130 was selected from the Educational Directory. Another random sample of 221 hospitals out of a total of 7,099 listed in the American Hospital Association Guide, was selected. Sample selection utilized stratified random sampling techniques.

3.A.4 Private

Since this user category is comprised of all U.S. households (families and single individuals), the statistics such as income, number of household units, and telephone and telegraph expenditures of U.S. households, were compiled using the Statistical Abstract and Consumer Guide. In 1975, there were 72.9 million households in the U.S. (56.2 million families and 16.7 million single households), which excluded the population residing in college dormitories, health care facilities, military bases, prisons, churches and various lodging/boarding houses.

3.B QUINTILE DISTRIBUTION OF USER POPULATION

A quintile distribution for each user category was based upon user expenditures for telecommunications services exclusive of telecommunications equipment that may be purchased or leased. The transmission expenditures by user industry sectors, as determined by consultant studies, were distributed among the user population in each of the sectors on the basis of the individual user's relative size in the sector.

Appropriate economic data impacting users' expenditures for telecommunications were used to determine each user's relative size in that sector. Different statistics were selected to determine the relative size of each user within a user category. Table III-29 summarizes the telecommunications expenditures and other economic data by industry sector as used in the accomplishment of this task. The major user population in each category was ranked by its estimated transmission expenditures. Identification of the quintiles followed (Tables III-30 through III-35)

3.C TYPICAL USER SELECTION AND SURVEY DESIGN

Median transmission expenditures were used as the criteria for selecting typical users from the appropriate quintiles in each user category with the exception of the private user category. Mean transmission expenditures were used as the criteria for selecting typical users in that category since the median values could not be identified or derived. The subsequent statements describe the approach taken to select the typical users.

Median users from the top three quintiles were selected as the typical users for the business user category. A different approach was used for the government category. Separate quintiles were developed for federal and state/local sectors. Median users from the top four quintiles in the federal sector and the top two quintiles in the state/local sector were selected as the typical users. In the case of the institutions category, separate quintiles were developed for education and health care and in both cases, median users from the top two quintiles were selected as the typical users. Only the top quintile was used to select a typical user from the private user category.

A brief questionnaire was designed to elicit the following user information:

- Users' present expenditures on transmission facilities and usage for each service; i.e., voice, data, and video.
- Their historical as well as expected average annual growth rates in terms of expenditures by service category.

Communications Managers or those administering telecommunications services at the typical users' locations were contacted either by telephone or by mailing the questionnaire. The data on their present as well as future telecommunications requirements for voice, data and video communications were received and analyzed.

Table III-29 - Transmission Expenditure

and

Economic Variables of User Categories

USER CATEGORY	ANNUAL TRANSMISSION EXPENDITURES ($ MILLIONS)	ECONOMIC VARIABLES ($ BILLIONS AND OTHER VARIABLES IN 000's) PRIMARY		SECONDARY	
BUSINESS: (1977 actual)					
Manufacturing	$ 5,871.0	Sales	$ 1,310	Employment	20,560
Banking/Finance	1,436.6	Assets	$ 1,710	Employment	2,030
Utilities	470.8	Employment	2,480	Sales	$ 143.03
Transportation	985.6	Employment	3,070	Sales	$ 72.61
Retail	795.7	Sales	$ 719.8	Employment	14,670
Insurance	1,035.2	Premium	$ 160.3	Employment	1,540
Professional Services	1,273.0	Employment	1,920	Sales	$ 78.84
	$11,867.9	Total Business Employment:	46,270		
GOVERNMENT:					
Federal (1977 actual)	1,649	Budget Outlay	417	Employment	2,468.7
State & Local (1976 actual)	1,008	Gen'l. Expend.	256	Employment	12,171.0
INSTITUTIONS: (1977 actual)					
Education (Colleges)	117	Enrollment	10,270.4		
Health Care (Hospitals)	375	Beds	1,407	Employment	3,213
PRIVATE: (1975 actual)					
Family Households	14,180	Income	874	Households	56,200
Single Households	3,090	Income	130	Households	16,700
	17,270		1,004		72,900

Table III-30 - Business Quintiles

ANNUAL TRANSMISSION EXPENDITURE LEVEL ($ MILLIONS)	% OF TOTAL TRANSMISSION EXPENDITURES	BUSINESS UNITS		AVERAGE TRANSMISSION EXPENDITURES ($ MILLIONS)	EMPLOYMENT		
		NO.	%		TOTAL (000's)	%	AVERAGE (000's
$20.7 and over	20%	49	.002	$48.4	6,607.5	14.3	134.8
6.47 - 20.7	20	200	.007	11.9	7,805.2	16.9	39.0
.16 - 6.47	20	1,295	.043	1.8	10,110.4	21.8	7.8
.003 - .16	20	89,296	2.948	.03	8,791.3	19.0	.098
Under .003	20	2,937,160	97.000	.001	12,955.6	28.0	.004
	100	3,028,000	100.0		46,270.0	100.0	

Table III-31 - Federal Government Quintiles

ANNUAL TRANSMISSION EXPENDITURE LEVEL ($ MILLIONS)	% OF TOTAL TRANSMISSION EXPENDITURES	FEDERAL UNITS		EMPLOYMENT		BUDGET OUTLAYS		AVERAGE TRANSMISSION EXPENDITURES ($ MILLIONS)
		NO.	%	TOTAL (000's)	%	TOTAL ($MILL.)	%	
$ 175 and over	40%	2	2.4	1,047.7	42.4	$ 144,490	34.7	$ 314.2
65 - 175	20	4	4.8	489.2	19.8	194,726	46.7	91.8
12 - 65	20	13	15.5	812.5	32.9	63,985	15.3	24.9
Under 12	20	65	77.3	119.3	4.9	13,754	3.3	5.1
	100	84	100.0	2,468.7	100.0	416,955	100.0	

Table III-32 - State/Local Government Quintiles*

ANNUAL TRANSMISSION EXPENDITURE LEVEL ($ MILLIONS)	% OF TOTAL TRANSMISSION EXPENDITURES	STATE/LOCAL UNITS		EMPLOYMENT			GENERAL EXPENDITURES			AVERAGE TRANSMISSION EXPENDITURES ($ MILLIONS)
		NO.	%	TOTAL (000's)	%	AVERAGE (000's)	TOTAL ($MILL.)	%	AVERAGE ($ MILL.)	
$ 8.9 and over	20 %	11	.02	1,810.2	15.0	164.6	$ 62,234	24.6	$ 5,658	$ 17.8
1.1- 8.9	20	54	.09	2,231.2	18.4	41.3	54,872	21.7	1,016	3.8
.0097 -1.1	20	20,509	32.89	2,726.8	22.6	.133	47,219	18.7	2.30	.00975
Under .0097	40	41,772	67.00	5,317.8	44.0	.127	88,483	35.0	2.12	.00958
	100.0	62,346	100.0	12,086	100.0		252,808	100.0		

*All figures exclusive of Alaska and Hawaii

Table III-33 - Institutions Quintiles - Education

(Colleges/Universities)*

ANNUAL TRANSMISSION EXPENDITURE LEVEL ($ 000's)	% OF TOTAL TRANSMISSION EXPENDITURES	COLLEGES/ UNIVERSITIES NO.	COLLEGES/ UNIVERSITIES %	AVG. TRANSMISSION EXPENDITURES ($000's)	AVERAGE ENROLLMENT (000's)
$253 and over	20 %	66	2.1	$ 343.7	30.2
117 - 253	20	133	4.3	172.0	15.1
73 - 117	20	244	7.9	88.0	7.7
38 - 73	20	443	14.3	54.7	4.8
Under 38	20	2,217	71.4	10.3	0.9
	100	3,103	100.0		

*All figures exclusive of Alaska and Hawaii

Table III-34 - Institutions Quintiles - Health Care

(Hospitals)*

ANNUAL TRANSMISSION EXPENDITURE LEVEL ($ 000's)	% OF TOTAL TRANSMISSION EXPENDITURES	HOSPITALS NO.	HOSPITALS %	AVG.TRANSMISSION EXPENDITURES ($000's)	AVERAGE # OF EMPLOYEES	AVERAGE # OF BEDS
$213 and over	20%	319	4.5	$233.2	1,750	950
129 - 213	20	478	6.8	153.5	1,395	550
80 - 129	20	765	10.9	96.2	825	360
46 - 80	20	1,275	18.1	56.7	450	225
Under 46	20	4,209	59.7	17.2	149	64
	100	7,046	100.0			

* All figures exclusive of Alaska and Hawaii

Table III-35 - Private Category Quintiles

MONTHLY TRANSMISSION EXPENDITURE LEVEL	% OF TOTAL TRANSMISSION EXPENDITURES	HOUSEHOLDS		AVERAGE MONTHLY TRANSMISSION EXPENDITURES	ANNUAL INCOME STATISTICS			
		NO. (MILL.)	%		TOTAL ($BILL.)	%	AVG. ($000's)	RANGE ($000's)
$27.50 and over	20 %	8.2	11.2	$ 35.10	$ 291.1	29.0	$ 35.5	$ 25.1 and over
22.30 - 27.50	20	12.0	16.5	24.00	231.9	23.1	19.3	17.3 - 25.1
19.40 - 22.30	20	13.6	18.7	21.20	212.4	21.2	15.6	12.7 - 17.3
15.00 - 19.40	20	16.7	22.9	17.20	165.7	16.5	9.9	7.3 - 12.7
Under 15.00	20	22.4	30.7	12.90	102.9	10.2	4.6	under 7.3
	100	72.9	100.0		1,004.0	100.0		

3.D TYPICAL USER'S DEMAND

Surveys of typical users provided detailed information on each typical user's expenditures on telecommunications and percentage usage of various services for voice, data and video applications. Additionally, users' own estimates of local, intra/interstate traffic as a proportion of the total traffic was obtained. Based upon this information, forecasts of typical user expenditures for long haul voice, data and video services were estimated for the years 1980, 1990 and 2000. Judgments were applied to the users' expected short term average annual growth rates in order to estimate the long term average annual growth rates. Information on users long haul intrastate as well as interstate portion of the total traffic for each service type was utilized to estimate their long haul transmission expenditures.

Using the present long haul expenditures and average annual growth rate information for each service type as obtained and derived from the survey results, each typical user's demand for long haul voice, data and video services was forecasted for the years 1980, 1990 and 2000. Tables III-36 through III-41 present the above forecasts.

3.E USER NORMS

Mean characteristics of user population in each user category were used in establishing the norms for the entire user category. While developing the quintiles, efforts were made to identify those mean characteristics of users in each quintile. Since only a relatively small percentage of users within each user category generates the majority of all long haul telecommunications traffic, only a few selected quintiles were used (as shown below) as the norms for the category.

User Category	No. of Quintiles
Business	Top 3 quintiles
Government	
• Federal	Top 4 quintiles
• State and Local	Top 2 quintiles
Institutions	
• Education	Top 2 quintiles
• Health Care	Top 2 quintiles
Private	Top quintile only

Table III-36 - Typical User Long Haul Demand

Business

($ Millions)

FIRST QUINTILE

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	27.13	89.3	50.93	74.3	91.21	55.8
DATA	3.25	10.7	15.62	22.8	66.00	40.4
VIDEO	-	-	2.00	2.9	6.21	3.8
TOTAL	30.38	100.0	68.55	100.0	163.42	100.0

SECOND QUINTILE

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	11.02	86.2	24.92	71.7	51.36	54.0
DATA	1.76	13.8	8.83	25.4	40.66	42.7
VIDEO	-	-	1.00	2.9	3.11	3.3
TOTAL	12.78	100.0	34.75	100.0	95.13	100.0

THIRD QUINTILE

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	.798	96.7	1.804	95.4	3.718	94.9
DATA	.027	3.3	.057	3.0	.141	3.6
VIDEO	-	-	.030	1.6	.059	1.5
TOTAL	.825	100.0	1.891	100.0	3.918	100.0

Table III-37 - Typical User Long Haul Demand

Government - Federal

($ Millions)

FIRST AND SECOND QUINTILE*

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	238.14	54.1	387.90	28.0	602.40	12.1
DATA	197.32	44.8	989.81	71.4	4,366.48	87.6
VIDEO	4.87	1.1	7.93	0.6	15.60	0.3
TOTAL	440.33	100.0	1,385.64	100.0	4,984.48	100.0

THIRD QUINTILE

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	54.41	68.9	104.56	40.4	170.32	18.2
DATA	24.56	31.1	152.07	58.8	762.82	81.4
VIDEO	-	-	2.10	0.8	4.13	0.4
TOTAL	78.97	100.0	258.73	100.0	937.27	100.0

FOURTH QUINTILE

SERVICE	1980 EXPENDITURES	1980 %	1990 EXPENDITURES	1990 %	2000 EXPENDITURES	2000 %
VOICE	5.66	29.5	10.88	16.5	17.72	8.7
DATA	13.52	70.5	54.70	82.8	185.68	90.8
VIDEO	-	-	.50	.7	.98	.5
TOTAL	19.18	100.0	66.08	100.0	204.38	100.0

*ONE USER MAKES UP ABOUT 30% OF THE TOTAL EXPENDITURES.

[redacted] [redacted]

[redacted]

ORIGINAL PAGE IS
OF POOR QUALITY

Table III-38 - Typical User Long Haul Demand

Government - State/Local

($ Millions)

FIRST QUINTILE	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	4.22	68.8	8.11	59.0	14.52	45.8
DATA	1.45	23.7	4.92	35.8	15.98	50.4
VIDEO	.46	7.5	.71	5.2	1.21	3.8
TOTAL	6.13	100.0	13.74	100.0	31.71	100.0

SECOND QUINTILE	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	.23	100.0	.56	93.3	1.18	94.4
DATA	-	-	.03	5.0	.05	4.0
VIDEO	-	-	.01	1.7	.02	1.6
TOTAL	.23	100.0	.60	100.0	1.25	100.0

Table III-39 - Typical User Long Haul Demand

Institutions - Education

($ Thousands)

FIRST QUINTILE

	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	188.5	98.7	321.9	97.7	524.3	96.8
DATA	2.4	1.3	4.9	1.5	11.6	2.2
VIDEO	-	-	2.8	0.8	5.5	1.0
TOTAL	190.9	100.0	329.6	100.0	541.4	100.0

SECOND QUINTILE

	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	51.4	94.8	87.8	91.8	143.0	89.1
DATA	2.8	5.2	5.8	6.1	13.7	8.5
VIDEO	-	-	2.0	2.1	3.9	2.4
TOTAL	54.2	100.0	95.6	100.0	160.6	100.0

Table III-40 - Typical User Long Haul Traffic

Institutions - Health Care

($ Thousands)

FIRST QUINTILE	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	218.8	98.4	517.9	96.3	1,018.8	94.0
DATA	3.5	1.6	14.8	2.7	54.9	5.0
VIDEO	-	-	5.0	1.0	9.8	1.0
TOTAL	222.3	100.0	537.7	100.0	1,083.5	100.0

SECOND QUINTILE	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	73.1	93.1	157.8	89.4	296.2	85.2
DATA	5.4	6.9	16.8	9.5	47.7	13.7
VIDEO	-	-	2.0	1.1	3.9	1.1
TOTAL	78.5	100.0	176.6	100.0	347.8	100.0

Table III-41 - Typical User Long Haul Demand

Private Category

First Quintile

($ Per Month)

	1980		1990		2000	
SERVICE	EXPENDITURES	%	EXPENDITURES	%	EXPENDITURES	%
VOICE	13.05	88.2	25.67	61.2	50.60	58.1
DATA	1.75	11.8	16.30	38.8	26.55	30.4
VIDEO *	-	-	-	-	10.00	11.5
TOTAL	14.80	100.0	41.97	100.0	87.15	100.0

*Home Video Services Only. CATV Included in Business Category.

Mean values for appropriate economic data as used in the development of quintiles were determined for each user category. Table III-42 provides a summary of those mean characteristics (i.e., norms) against which the similar characteristics of typical users were compared.

4.0 SIGNIFICANT CONCLUSIONS

The quintile distribution of the user population in each user category provided the basis for analyzing the relative size of each user in the category. The following is a brief analysis of each user category.

4.A BUSINESS

About 1,600 (less than .05%) of the largest businesses represent 60% of the category's total transmission expenditures with an average annual transmission expenditure of $4.61 million. The remaining 99.95% of the total business firms (over 3 million) make up the rest (40%) of the total transmission expenditures with an average annual expenditure of $1,569. This shows that a relatively small number of firms have a potential need for sophisticated telecommunications systems and services, and these are the likely business candidates to determine the demand for an advanced communications transmission medium or system.

4.B GOVERNMENT

Only 19 federal departments of the total 84 departments and agencies, each spending $12.0 million per year or more on telecommunications services, make up 80% of the federal government's total transmission expenditures. The remaining 65 departments and agencies make up the rest.

All state governments, except for Wyoming, and the 18 largest city governments spend over $1 million each on telecommunication services. These 65 largest state and local government organizations account for 40% of this sector's total transmission expenditures with an average annual transmission expenditure of $6.14 million. The remaining government units have average transmission expenditures of $9,634 per year. The typical user surveys indicate that most local governments do not have a centralized telecommunications department or a c. mmunications manager because each local sub-unit is run independently (police, . re, etc.) and the communications services are generally controlled by administrative personnel whereas the federal government and most states, to some extent, have centralized control over communications requirements and expenditures and more often than not have a communications manager. This seems to indicate that the local governments will show a lag in the implementation of various innovative telecommunications services.

4.C INSTITUTIONS

One hundred and ninety-nine institutions of higher education (6.4% of the total) make up about 40% of the education sector's total transmission expenditures, each spending more than $117,000 per year with an average annual expenditure of $229,000. The remaining colleges and universities have average expenditures of $23,602 per year.

Table III-42 - User Norms

NORM STATISTIC (ANNUAL)	BUSINESS	GOVERNMENT		INSTITUTIONS		PRIVATE
		FEDERAL	STATE/LOCAL	EDUCATION	HEALTH CARE	
Transmission Expenditure ($ Millions)	4.61	69.5	6.14	.229	.185	35.10*
Employment	15,883	123,653	62,175	-	1,537	-
Enrollment	-	-	-	20,108	-	-
Beds	-	-	-	-	710	-
Budget Outlay ($ Millions)	-	21,221	-	-	-	-
General Expenditure ($ Millions)	-	-	1,802	-	-	-
Transmission Expenditure per Employee ($)	290	562	99	-	120	-
Budget Outlay per Employee ($)	-	171,617	-	-	-	-
General Expenditure per Employee ($)	-	-	28,983	-	-	-
Transmission Expenditure per Enrollee ($)	-	-	-	11.39	-	-
Transmission Expenditure per Bed ($)	-	-	-	-	261	-
Transmission Expenditure per dollar of Budget Outlay (cents)	-	.3273	-	-	-	-
Transmission Expenditure per dollar of General Expenditure (cents)	-	-	.3407	-	-	-
Income	-	-	-	-	-	35,500
Transmission Expenditure per dollar of Income (cents)	-	-	-	-	-	1.19

*Monthly Expense ($)

Seven hundred and ninety seven of the total 7099 hospitals (less than 12%) make up about 40% of the health care sector's total transmission expenditures, each spending over $129,000 per year with an average of $185,000. The remaining hospitals make up the rest of the sector's transmission expenditures (60% of the total), with an average annual expenditure of $34,947. This seems to indicate that a relatively small number of colleges/universities and hospitals have a potential need for advanced telecommunications systems and services.

4.D PRIVATE

The households in the top quintile will have a potential need for sophisticated telecommuications systems and services because they are the ones with the highest monthly telephone expenditures as well as in the highest income group. Specifically, the top quintile represents 8.2 million households (11.2% of the total households in the U.S.) with a monthly telephone and telegraph expenditure of $27.50 and above, with a group average of $35.10 a month. Additionally, this group contributes about 29% to the total household income in the U.S. with an annual income greater than $25,100 and an average of $35,500. The remaining 88.8% of the households accounting for 80% of the total telecommunications expenditures has an average expenditure of $17.80 per month, with an average annual income of $11,019. This group utilizes telephone service more as a necessity and will not have much potential for advanced telecommunications systems or services.

The typical users in each sector were compared to the norms developed for each sector. Tables III-43 and III-44 present these comparisons. In all the comparisons, the typical users would be those with the highest potential need for advanced telecommunications systems and services because they are the ones who currently have a large budget for communications.

Table III-43 - Typical User Vs. Group Norm

BUSINESS SECTOR

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1	2	3
Transmission Expenditure ($ Mill.)	4.61	35.00	14.00	.85
Employment	15,883	141,394	26,400	4,700
Transmission Expenditure per Employee ($)	290	248	530	181

GOVERNMENT (FEDERAL)

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1 and 2*	3	4
Transmission Expenditure ($ Mill.)	69.5	450	85	20
Employment	123,653	940,549	82,051	29,491
Budget Outlay ($ Mill.)	21,221	97,930	16,738	2,606
Transmission Expenditure per Employee ($)	562	478	1,036	678
Budget Outlay per Employee ($)	171,617	104,120	203,995	88,366
Transmission Expenditure per Dollar of Budget Outlay (cents)	.3273	.4595	.5078	.7675

GOVERNMENT (STATE/LOCAL)

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1	2
Transmission Expenditure ($ Mill.)	6.14	14.00	3.8
Employment	62,175	139,000	38,114
General Expenditure ($ Mill.)	1,802	5,282	1,088
Transmission Expenditure per Employee ($)	99	101	100
General Expenditure per Employee ($)	28,983	38,000	28,546
Transmission Expenditure per Dollar of General Expenditure (cents)	.3407	.2651	.3493

*ONE USER MAKES UP ABOUT 30% OF THE TOTAL EXPENDITURES.

Table III-43 - Typical User Vs. Group Norm - cont.

INSTITUTIONS (EDUCATION)

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1	TYPICAL USER IN QUINTILE 2
Transmission Expenditure ($)	229,000	400,000	175,000
Enrollment	20,108	34,681	14,452
Transmission Expenditure per Enrollee ($)	11.39	11.53	12.11

INSTITUTIONS (HEALTH CARE)

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1	TYPICAL USER IN QUINTILE 2
Transmission Expenditure ($)	185,000	443,000	165,000
Employment	1,537	2,993	1,403
Beds	710	1,036	587
Transmission Expenditure per Employee ($)	120	148	118
Transmission Expenditure per Bed ($)	261	428	281

PRIVATE CATEGORY

STATISTICAL MEASURE	GROUP NORM	TYPICAL USER IN QUINTILE 1
Transmission Expenditure ($/mo.)	35.10	30.00
Annual Income (000's)	35,500	32,000
Transmission Expenditure per Dollar of Income (cents)	1.19	1.13

TASK 3.C DEMOGRAPHICS OF USER CATEGORIES

1.0 STATEMENT OF WORK

The Contractor shall determine and display on a map of the United States the distribution of each of the three communications services, by user category, for the years 1980, 1990, and 2000.

2.0 INTRODUCTION

The geographical distribution of user demand is the third important element which provides information useful in the determination of satellite system configurations in addition to identifying the patterns depicting regional concentration of traffic volume by user category.

3.0 METHODOLOGY

The task involved considerable research on databases containing information on socio-economic activity levels and the demographics of user categories by Standard Metropolitan Statistical Areas (SMSAs) in the U.S. Fourteen databases, out of a total of 27 available, were selected for the geographical distributions of the users' net long haul traffic volume forecasts for voice and data services. Similar distributions for video demand could not be developed by user category because geographically based indicators were not available on a user category basis.

The geographical distribution process utilized the capabilities of the Western Union Market Distribution Model (MDM). Databases were selected for each user-service combination and appropriate weightings were assigned to these databases to calculate the weighted market value by SMSA. The weightings represented the amount of influence that each database would have, relative to the other databases selected, on a specific user-service traffic volume, e.g., Business-Voice. The SMSA market values expressed as a percentage of the total market value for 275 SMSA's, were grouped into the respective U.S. regions (the nine U.S. regions defined in Task 2.D), and were applied to the specific user-service traffic volume forecasts. The results are summarized and displayed on U.S. maps.

Traffic distributions by user category and by service category, for each of the three forecasts years, were analyzed and the regions with the largest concentrations of a user category's voice and data communications traffic were identified. Also identified were the dominant users of voice and data services within each region.

3.A RESEARCH ON DATABASES

Telecommunications traffic in a geographical area is more often than not a direct function of the economic activity in that area. Therefore, the task involved intensive research on such economic data by SMSA's. Various sources such as the Rand McNally Marketing Guide, the U.S. Department of Commerce, Computer World, the Encyclopedia of Associations, the CBS Almanac, the Dow Jones Irwin Business Almanac, Future Systems Inc., and International Data Corporation were investigated. As a first step, in-house sources, particularly Strategic Planning Model databases, were reviewed for their completeness and applicability to the task effort. Additional databases such as government employees, major military installations, computer mainframe locations, and terminals within SMSA's were acquired from outside sources. These new databases were then created in the MDM system so that economic data in relevant databases could be manipulated and applied. Table III-45 provides a listing of databases used in the geographical distribution of each user category's traffic for voice as well as data services.

Table III-45 - Databases Used in Geographical Distributions

No.	Database	Source
1.	Total Telephones	FCC Statistics
2.	Business	FCC Statistics
3.	Value Added by Manufacturers	Rand McNally
4.	Mainframe Computer Locations	International Data Corp.
5.	Telex Terminals	Western Union
6.	TWX Terminals	Western Union
7.	Computer Terminal Locations	International Data Corp.
8.	U.S. Mail Flow	U.S. Postal Service
9.	Federal Government Employees	Statistical Abstract
10.	Major Military Installation	Rand McNally
11.	State Government Employees	Statistical Abstract
12.	Local Government Employees	Statistical Abstract
13.	U.S. Population	Rand McNally
14.	Retail Sales	Rand McNally

3.B DATABASE SELECTION AND WEIGHTING FACTORS

Users in each of the four user categories perform different roles in the U.S. economy, and as a result they differ from each other in terms of their primary functions. Therefore, different economic databases that perceivably had some impact on user's needs for voice and data communications services were selected for each user category. Appropriate weightings were assigned to each database to reflect the amount of influence it would have on the traffic potential of that category service. A summary of the databases selected and the weighting factors assigned to each by combination of user and service categories followed. It should be pointed out that the geographical distribution of users' video demand was not feasible for the same reasons explained in section 2 of Task 3.C. The weighting factors for voice and data traffic are shown below:

3.B.1 Business

Business users of voice services primarily communicate with other business users. However, they also use these same voice services to communicate with the other three sectors and the amount of traffic varies in accordance with the activity level of each. In view of this, total telephones, business telephones and value added by manufacturers in an SMSA were chosen as the indicators of business-voice traffic potential in that area. "Business telephones" was given the highest weighting in the development of average market values by SMSA, as shown in Table III-46.

Table III-46 - Business - Voice Traffic

Weighting Factor

Database	Weighting Factor
Total Telephones	0.1
Business Telephones	0.6
Value Added by Manufacturer	0.3
Total	1.0

On the other hand, business data traffic in an SMSA is a function of commercial activity, presence of data communication terminals and computer centers, U.S. mail flow, and value added by manufacturer in that area. Shown below in Table III-47 are the databases and their respective weighting factors assigned for the purpose of distributing business-data traffic volumes by regions.

Table III- 47 - Business - Data Traffic

Database	Weighting Factor
Mainframe Computer Locations	0.25
Value Added by Manufacturer	0.10
Telex Terminals	0.15
TWX Terminals	0.15
Computer Terminal Locations	0.25
U.S. Mail Flow	0.10
Total	1.00

3.B.2 Government

Different databases were selected for federal and state/local government sectors because of the versatile role of the Federal Government sector in the U.S. economy and its' performance of several functions beyond that of public administration.

3.B.2.A Federal

The Department of Defense is the largest user of telecommunications in the federal government, therefore, a database providing the number of major military installations by SMSA was considered an important indicator of federal communications traffic volume in a geographical area. Also chosen was the database containing federal government employee statistics by SMSA. The selected databases and their weightings used in the geographical distribution of government sector communications traffic are shown below in Table III- 48.

Table III-48 - Federal Government
Voice and Data Traffic Factors

Database	Federal-Voice Traffic	Federal-Data Traffic
Federal Gov't. Employees	0.7	0.4
Major Military Installations	0.3	0.6
Total	1.0	1.0

3.B.2.B State/Local

About 450 of the largest State/Local governments (i.e., the 48 contiguous states and 400 of the largest city governments) account for approximately 47% of the sector's total transmission expenditures. At administration levels, the States and Major City Governments have a community of interest among themselves and with federal government departments and agencies. Therefore, government employee data by SMSA were deemed the most appropriate indicators of this sector's long haul voice and data communications volumes in that area. The State/Local weighting factors for voice and data are shown below in Table III-49.

III-49 - State/Local Government
Voice and Data Traffic Factors

Database	State/Local Voice Traffic	State/Local Data Traffic
State Gov't. Employees	0.6	.5
Local Gov't. Employees	0.3	.2
Fed. Gov't. Employees	0.1	.3
Total	1.0	1.0

3.B.3 Institutions

Hospitals and institutions of higher education provide services to the population residing within the vicinity. The resident population in these sectors, such as patients in hospitals and students in college dormitories, generate significant voice communications traffic, whereas almost all data traffic is generated by the employees in those institutions. At present, there is very little communication among the user institutions in each of the above two sectors, but there exists an interest in the development of various common networks to pool information from some common databases, e.g., central library systems, medical research and diagnostics. Moreover, the employees of the above institutions also have a potential need to communicate with the business and government organizations.

Shown in Table III-50 are the selected databases and their weighting factors:

III-50 - Institutions - Voice and Data Traffic Factors

Database	Institutions Voice Traffic	Institutions Data Traffic
U.S. Population	0.6	0.6
Total Telephones	0.4	-
U.S. Mail Flow	-	0.4
Total	1.0	1.0

3.B.4 Private

Private users, i.e., the residential population in U.S. Households, communicate with other residents in that area as well as in remote areas. Most of their communications with Business, Governments and Institutions are local in nature. Therefore, population and total telephones were chosen as the major economic indicators for the distribution of this category's communications traffic volumes. Additionally, "Retail Sales" was selected as another economic indicator because of the fact that retail businesses are normally established within the population centers in the U.S., and have some impact on this sector's voice communications traffic. Table III-51 summarizes the databases and the weighting factors used for the private user category.

III-51 - Private User - Voice and Data Traffic Factors

Database	Private Voice Traffic	Private Data Traffic
Population	0.5	0.3
Total Telephone	0.3	0.2
Retail Sales	0.2	-
U.S. Mail Flow	-	0.5
Total	1.0	1.0

3.C GEOGRAPHICAL DISTRIBUTION OF OF TRAFFIC VOLUMES

Once the databases containing appropriate information on market variables had been selected and the relative importance of each determined,

the Market Distribution Model (MDM) developed the weighted market value for each SMSA, representing the combined impact of the market variables on the traffic potential in that area. Upon normalizing these values, the MDM provides a percent distribution of the traffic volume by SMSA.

In view of the task objective, the SMSA data as developed above was consolidated into respective regions. It should be noted that the market values of SMSA's, as determined through the above process, would change over a period of time due to the dynamic nature of the socio-economic structure and the activity level within an SMSA. These changes would not impact any short or medium time period forecasts but their impact on a long term forecast such as for this study, is worth considering. Since the task required forecasting traffic volumes of each user-service combination by region, the changing trends of SMSA market values become submerged when this data is grouped into regions.

However, an analysis of the regions indicated that the socio-economic structure of an SMSA is very dependent upon that of an adjacent SMSA within the same region, as exemplified by the socio-economic dependence of New York, Connecticut and New Jersey SMSA's along their common borders.

Furthermore, as explained earlier in the methodology section of this task, such geographical distributions of users' video demand could not be developed because of the omni-directional nature of video traffic distribution. Therefore, the task objective was reduced to developing 8 geographical distributions; 2 service and 4 user categories. These distributions are constant for the forecast time horizon.

Regional market values, developed as a percentage of the total for the 48 contiguous United States, were applied to the traffic volume forecasts of each user-service combination (except video). This yielded the 8 geographical distributions shown in Tables III-52 and III-53 and the same were displayed on U.S. maps (Figures III-3 to III-6).

4.0 SIGNIFICANT CONCLUSIONS

The geographical distributions of users' traffic volumes for voice and data services were analyzed to identify the major user concentrations in the U.S. by service type. An analysis of user distribution expressed as a percentage of the total regional traffic volume for each service type (Tables III-54 and III-55) identified the dominant user category within each region. The following conclusions were drawn:

1) Middle Atlantic and East North Central regions will continue to have the greatest concentration of the Business, Institutions and Private users long haul voice and data communications traffic.

2) Major concentrations of the Government users long haul voice and data traffic will continue to be in the South Atlantic, East South Central and Mountain regions.

Table III-52

GEOGRAPHICAL DISTRIBUTION OF LONG HAUL TRAFFIC

VOICE SERVICES

(HALF VOICE CIRCUITS-THOUSANDS)

REGION	BUSINESS			GOVERNMENT			INSTITUTIONS			PRIVATE		
	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
New England	78	212	637	14	28	51	5	9	17	43	106	243
Middle Atlantic	216	588	1758	39	82	145	15	28	52	139	347	792
East North Central	219	597	1784	36	75	134	16	30	55	142	357	813
West North Central	68	185	552	19	39	70	4	9	16	49	122	279
South Atlantic	155	423	1266	63	134	238	9	18	34	105	262	598
East South Central	42	114	340	18	39	69	3	6	11	33	83	190
West South Central	83	227	680	29	60	106	6	11	20	64	161	368
Mountain	41	111	331	18	37	67	2	5	8	30	74	170
Pacific	141	384	1147	39	81	143	9	17	31	103	259	590
TOTAL	1043	2841	8495	275	575	1023	69	133	244	708	1771	4043

Table III-53

GEOGRAPHICAL DISTRIBUTION OF LONG HAUL TRAFFIC

DATA SERVICES

(TRANSMIT AND RECEIVE - TERABITS/YR)

REGION	BUSINESS			GOVERNMENT			INSTITUTIONS			PRIVATE		
	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
New England	53.7	360.0	1491.5	10.7	53.3	177.3	0.2	5.6	8.2	0.006	2.4	2.9
Middle Atlantic	201.3	1348.6	5587.3	29.0	144.4	480.3	0.5	19.3	28.6	0.021	8.3	10.1
East North Central	167.2	1120.1	4640.3	25.2	125.6	417.5	0.5	19.3	28.6	0.021	8.5	10.2
West North Central	54.6	365.7	1515.3	14.5	72.2	240.2	0.2	6.6	9.8	0.007	2.9	3.5
South Atlantic	114.3	765.8	3172.4	56.5	282.2	938.5	0.4	13.2	19.5	0.015	5.9	7.2
East South Central	29.1	194.3	804.9	15.2	75.6	251.3	0.1	3.9	5.8	0.004	1.7	2.1
West South Central	80.2	537.2	2225.4	24.1	120.0	399.0	0.2	9.0	13.4	0.009	3.9	4.7
Mourtain	28.1	188.6	781.3	15.8	78.9	262.3	0.1	3.4	5.0	0.004	1.6	2.0
Pacific	124.5	834.3	3456.5	31.9	158.9	528.3	0.3	10.7	15.9	0.013	5.4	6.5
TOTAL	853.0	5714.6	23674.9	222.9	1111.1	3694.7	2.5	91.0	134.8	0.1	40.6	49.2

Table III-54 USER SHARE OF REGIONAL TRAFFIC VOLUME

VOICE SERVICES

(HALF VOICE CIRCUITS -%)

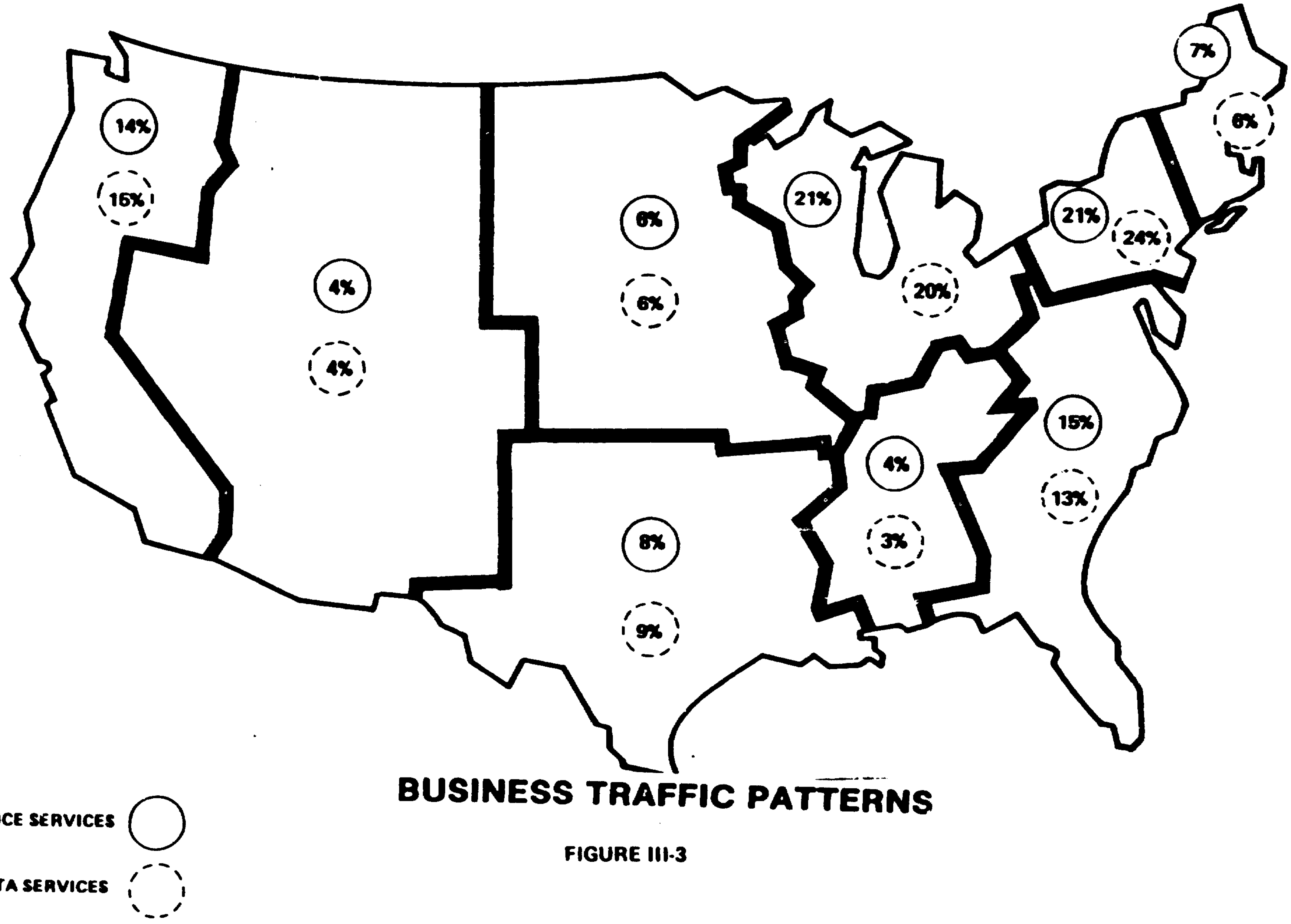
REGION	BUSINESS	GOVERNMENT	INSTITUTIONS	PRIVATE	TOTAL
NEW ENGLAND					
1980	55.7	10.0%	3.6%	30.7	100.0%
1990	59.7	7.9	2.5	29.9	100.0
2000	67.2	5.4	1.8	25.6	100.0
MIDDLE ATLANTIC					
1980	52.8	9.5	3.7	34.0	100.0
1990	56.3	7.8	2.7	33.2	100.0
2000	64.0	5.3	1.9	28.8	100.0
EAST NORTH CENTRAL					
1980	53.0	8.7	3.9	34.4	100.0
1990	56.4	7.1	2.8	33.7	100.0
2000	64.0	4.8	2.0	29.2	100.0
WEST NORTH CENTRAL					
1980	48.6	13.6	2.8	35.0	100.0
1990	52.1	11.0	2.5	34.4	100.0
2000	60.2	7.6	1.7	30.5	100.0
SOUTH ATLANTIC					
1980	46.7	19.0	2.7	31.6	100.0
1990	50.5	16.0	2.2	31.3	100.0
2000	59.3	11.1	1.6	28.0	100.0
EAST SOUTH CENTRAL					
1980	43.8	18.7	3.1	34.4	100.0
1990	47.1	16.1	2.5	34.3	100.0
2000	55.7	11.3	1.8	31.2	100.0
WEST SOUTH CENTRAL					
1980	45.6	15.9	3.3	35.2	100.0
1990	49.5	13.0	2.4	35.1	100.0
2000	57.9	9.0	1.7	31.4	100.0
MOUNTAIN					
1980	45.0	19.8	2.2	33.0	100.0
1990	48.9	16.3	2.2	32.6	100.0
2000	57.5	11.6	1.4	29.5	100.0
PACIFIC					
1980	48.3	13.4	3.0	35.3	100.0
1990	51.8	10.9	2.3	35.0	100.0
2000	60.0	7.5	1.6	30.9	100.0

Table III-55 USER SHARE OF REGIONAL TRAFFIC VOLUME

DATA SERVICES

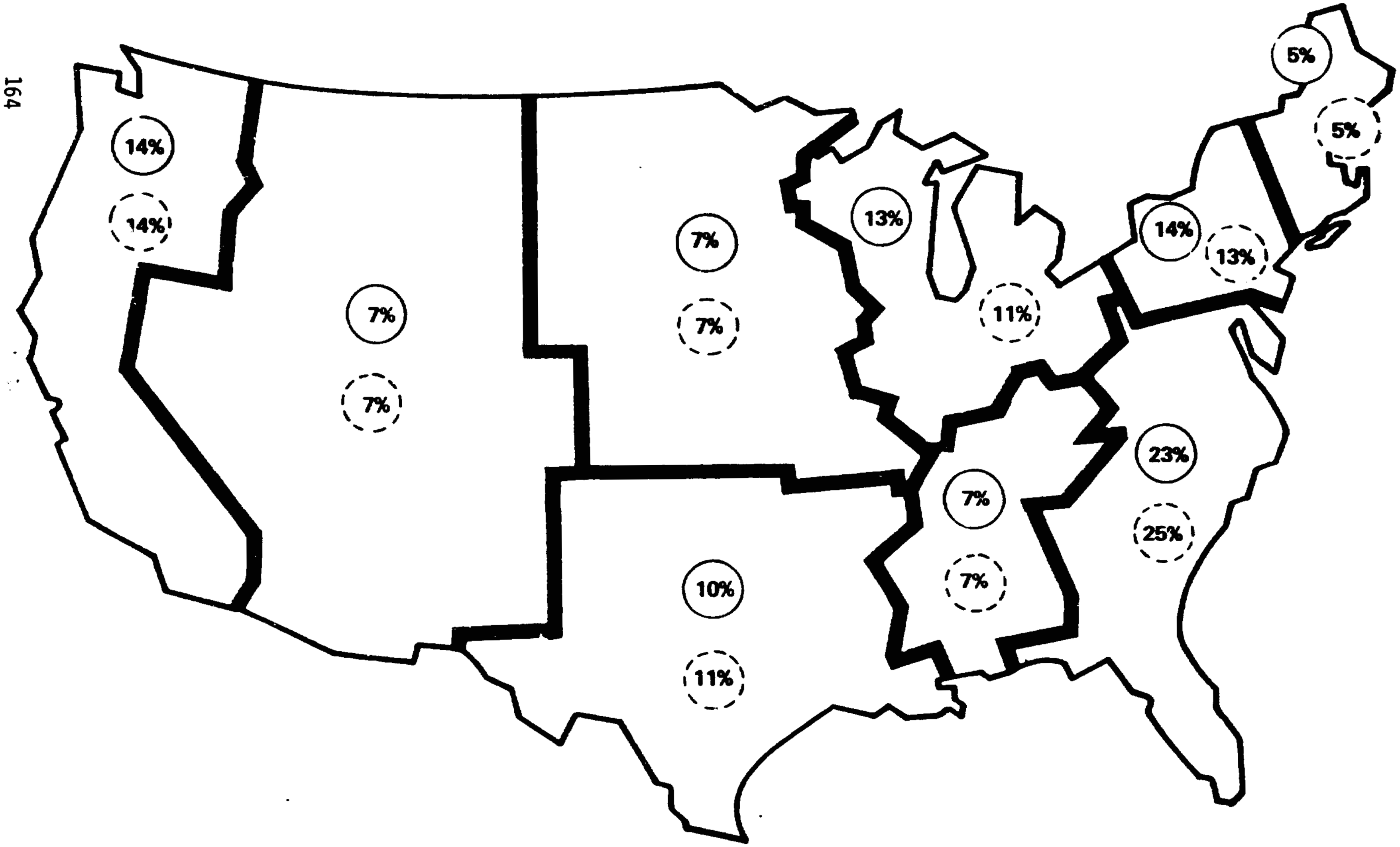
(TERABITS/YEAR - %)

REGION	BUSINESS	GOVERNMENT	INSTITUTIONS	PRIVATE	TOTAL
NEW ENGLAND					
1980	83.1%	16.6%	0.3%	0%	100.0%
1990	85.5	12.7	1.3	0.5	100.0
2000	88.8	10.5	0.5	0.2	100.0
MIDDLE ATLANTIC					
1980	87.2	12.6	0.2	0	100.0
1990	88.7	9.5	1.3	0.5	100.0
2000	91.4	7.9	0.5	0.2	100.0
EAST NORTH CENTRAL					
1980	86.7	13.0	0.3	0	100.0
1990	88.0	9.8	1.5	0.7	100.0
2000	91.0	8.2	0.6	0.2	100.0
WEST NORTH CENTRAL					
1980	78.8	20.9	0.3	0	100.0
1990	81.7	16.1	1.5	0.7	100.0
2000	85.7	13.6	0.5	0.2	100.0
SOUTH ATLANTIC					
1980	66.7	33.0	0.3	0	100.0
1990	71.8	26.4	1.2	0.6	100.0
2000	76.6	22.7	0.5	0.2	100.0
EAST SOUTH CENTRAL					
1980	65.5	34.3	0.2	0	100.0
1990	70.5	27.5	1.4	0.6	100.0
2000	75.6	23.6	0.6	0.2	100.0
WEST SOUTH CENTRAL					
1980	76.7	23.1	0.2	0	100.0
1990	80.2	17.9	1.3	0.6	100.0
2000	84.2	15.1	0.5	0.2	100.0
MOUNTAIN					
1980	63.9	35.9	0.2	0	100.0
1990	69.2	29.0	1.2	0.6	100.0
2000	74.3	25.0	0.5	0.2	100.0
PACIFIC					
1980	79.4	20.4	0.2	0	100.0
1990	82.7	15.7	1.1	0.5	100.0
2000	86.2	13.2	0.4	0.2	100.0



BUSINESS TRAFFIC PATTERNS

FIGURE III-3

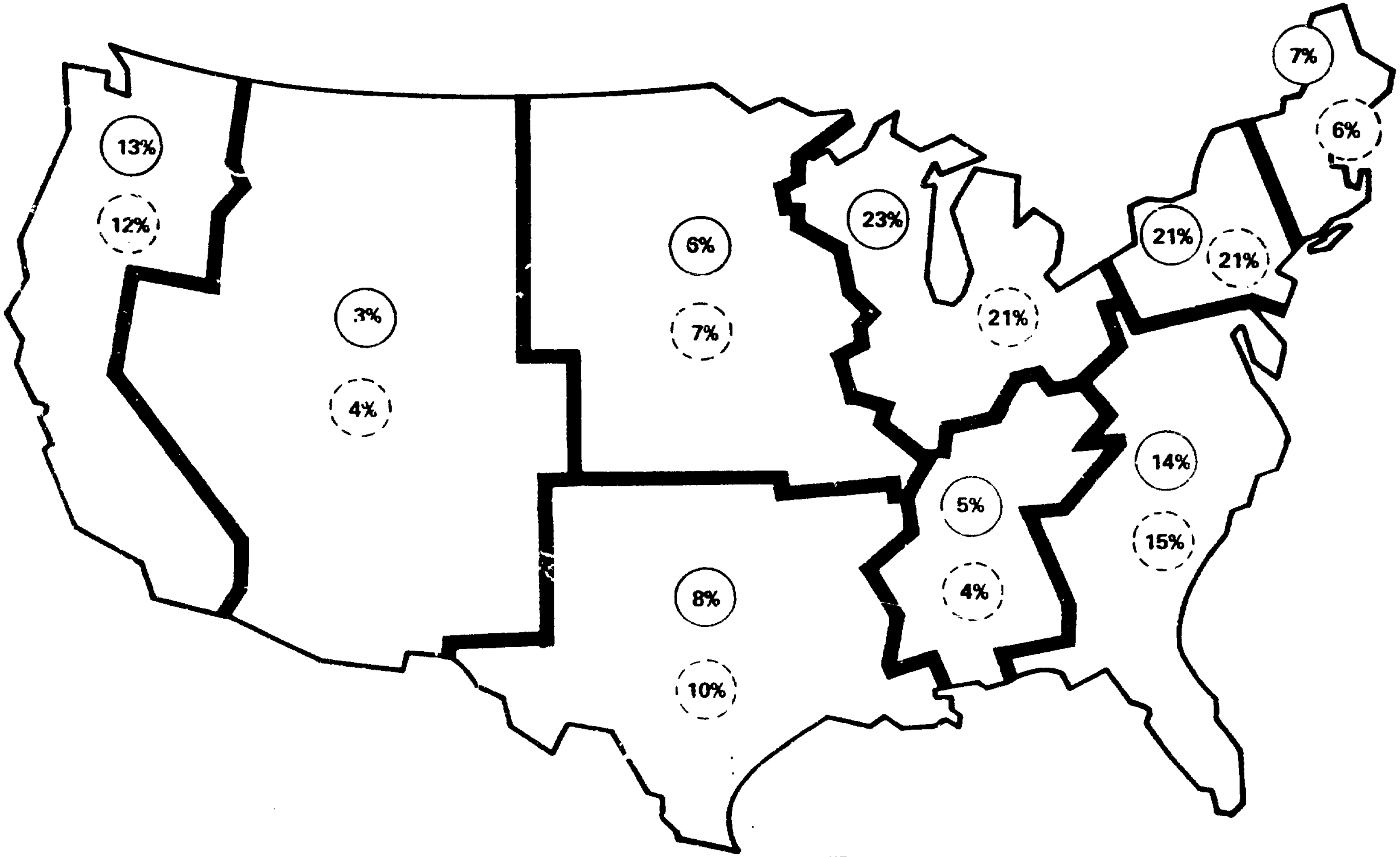


GOVERNMENT TRAFFIC PATTERNS

VOICE SERVICES

DATA SERVICES

FIGURE III-4



INSTITUTIONAL TRAFFIC PATTERNS

VOICE SERVICES

DATA SERVICES

FIGURE III-5

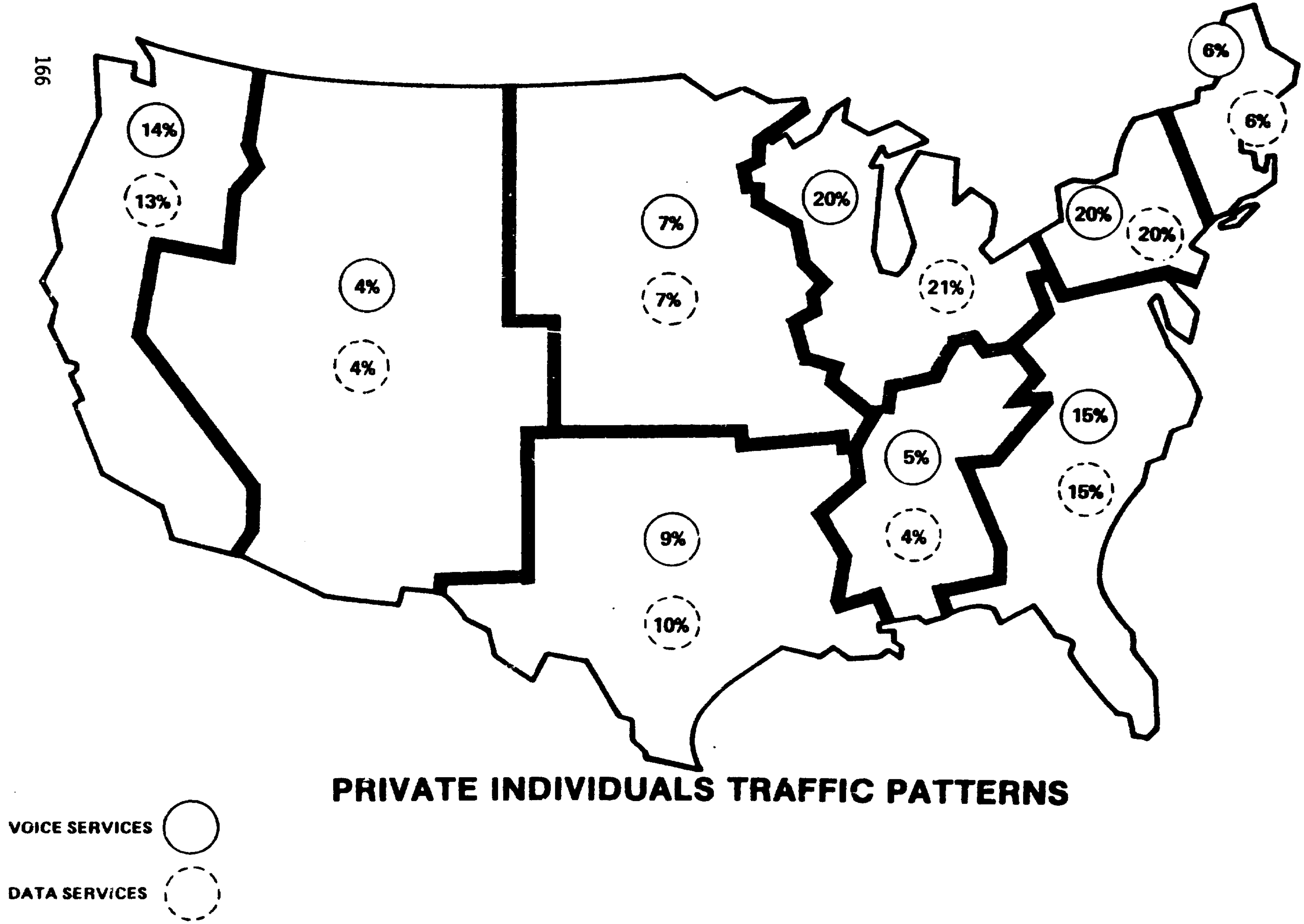

14%
13%
4%
4%
7%
7%
9%
10%
20%
21%
5%
4%
15%
15%
20%
20%
6%
6%
PRIVATE INDIVIDUALS TRAFFIC PATTERNS
VOICE SERVICES
DATA SERVICES

FIGURE III-6

3) Business will continue to be the dominant user category within each region for voice and data communications services.

4) The percentage distribution of each user's long haul traffic for each service type, by region, is not expected to change over the next 20 years.

SECTION 4

TASK 4 METROPOLITAN AREA STUDY

1.0 STATEMENT OF WORK

The contractor shall analyze the communications needs of a large metropolitan area. The metropolitan area to be studied will be recommended by Western Union and approved by the NASA project manager. The contractor shall determine and display, by appropriate tabular and graphical means, the local geographical distribution of services and traffic volume within the selected metropolitan area for the years 1980, 1990, 2000.

2.0 INTRODUCTION

Communications within and between most metropolitan areas is transmitted over cable or microwave facilities or both. Within the last two years, in a limited number of metropolitan areas, satellite transmission has become available.

As the communications needs of metropolitan areas grow, both in terms of the volume of traffic and the sophistication of the services that are in use, there is some concern that the necessary transmission facilities might not be available. For this reason NASA has asked that the communications needs of a large metropolitan area be analyzed.

The communications needs of the metropolitan area were studied in terms of the local distribution of services and traffic volumes. Data, voice and video services and their applications were analyzed, including high speed data, electronic mail and videoconferencing. The acceptance of new transmission facilities such as earth stations and fiber optics were also evaluated.

Local geographic areas with concentrations of voice and data traffic were identified and forecasts were developed for the future demand for services in the metropolitan area.

2.A PURPOSE

This task is intended to provide specific information and analysis as to what the future communications needs of a large metropolitan area will be, what services and applications will be employed, who the expected users will be, and where in the metropolitan area the demand will emanate. The results of the task are intended to supply NASA with a basis for estimating the future needs of metropolitan areas.

2.B SCOPE

This task was an investigation of a large metropolitan area which included primary as well as secondary research.

The major emphasis of the primary research was a personal interview survey of corporations and institutions that represented a cross section of users of communications services in the selected metropolitan area.

The secondary research efforts were concentrated on inforamtion provided by the local telephone company, traffic statistics secured from Western Union TWX/Telex and Private Wire customer files, maps of private and common carrier microwave systems in operation supplied by telecommunication engineering companies, and consultant reports.

The major focus of the task was to analyze for NASA the communications needs of a large metropolitan area for the years 1980, 1990, 2000. If the primary and secondary sources failed to provide enough data to analyze the communications demand in the year 2000, a scenario of the communications needs in the metropolitan area would be created.

2.C APPROACH

The approach that was used in this task was decided upon after careful consideration of the type of information that had to be researched. This approach was a combination of both primary and secondary market research.

The primary market research centered on conducting a broad personal interview survey in the metropolitan area. A questionnaire was designed to gather statistics on the current and future traffic volumes for data, voice and video services. Questions were included to elicit from the users information gauging their acceptance or resistance to new transmission facilities such as earth stations and fiber optics. Users were also queried on their current and future usage of electronic mail, videoconferencing and high speed data.

Criteria for selecting a metropolitan area were developed and Phoenix was chosen as the metropolitan area. The criteria for selection of the metropolitan area and the whole selection process is described in detail.

Secondary sources of information were used to provide economic and demographic statistics of Phoenix and data on the existing local telecommunications facilities.

All the information which was collected from the primary and secondary research was analyzed. Some computer modelling was used in the analysis of the survey data. As a result of this computer analysis, the local geographical distribution of services and traffic volume within the Phoenix metropolitan area for the years 1980, 1990, 2000 were determined and interpreted.

3.0 SELECTION OF METROPOLITAN AREA

The purpose of this section is to explain why Phoenix was chosen as the metropolitan area whose communications traffic demand was studied in depth. Included is a description of the criteria used for selection, a comparison of the candidates that were considered, and the methodology employed in the final selection process.

3.A CRITERIA FOR SELECTION

In evaluating candidate metropolitan areas, a number of criteria were developed to assist in the selection process. The criteria included:

- Size and growth of population
- Diversity of industry representation
- Level of local telecommunications
- Availability of local sources of information

3.A.1 Size and Growth of Population

Population growth was considered important because the metropolitan area selected would have to be representative of other metro areas in the contiguous 48 states over the 1980 to the year 2000 time frame. A metropolitan area which is growing and developing over the next 20 years should be more typical of a metro area of the future than a metropolitan area whose growth has peaked with little change in the future expected.

The current population of the metropolitan area was considered very significant and two parameters for elimination were established:

- Metropolitan areas with populations below 500 thousand were not considered because the level and sophistication of communications in these metropolitan areas would not be sufficient to permit a study of this type to be done properly.

- Metropolitan areas with populations greater than 2.5 million were eliminated as candidates because their physical size and the level of communications traffic would demand a commitment of time and funds beyond that allocated in the study. In addition, most metropolitan areas in this size class (e.g., New York, Chicago, Philadelphia) are in their mature stage of development and are not expected to change appreciably in the next 20 years.

3.A.2 Diversity of Industry Representation

In order for a metropolitan area's current and future telecommunications demand to be thought of as being typical of the demand of other metro areas, it should have a diverse representation of industry. Every industry and organization has telecommunications requirements which are unique. For a metropolitan area to be considered it had to have a diverse representation from the manufacturing, banking, life insurance, retailing, hospital care, education, service and government sectors.

3.A.3 Level of Local Telecommunications

There were two indicators which were used to measure the level of local telecommunications in candidate metropolitan areas. The first indicator was the number of telephones per capita while the second was the dollar value of computers installed.

The number of telephones per capita was thought to be a good barometer of the volume of voice traffic in the metropolitan area, while the dollar value of computers installed was viewed as being indicative of data traffic volumes.

3.A.4 Availability of Local Sources of Information

In reviewing the amount and type of information which had to be gathered for the Metropolitan Area Study, it became apparent that a key ingredient to its success would be the availability of local sources of information. Some of the sources of information were to include:

- The local Chamber of Commerce which could assist in arranging appointments for the personal interview survey, and suggest additional sources of information.

- The telephone company serving the area to provide information on local telephone usage, the location of switching offices, and any plans for the introduction of new services in the metropolitan area.

- Local real estate developers and planning commissions that could be a source of information concerning the locations of future residential and commercial construction.

3.B COMPARISON OF CANDIDATES

This section provides a listing of preliminary candidate metropolitan areas that were considered, and a description of how the final candidates were selected.

3.B.1 Preliminary List of Candidates

In the proposal made to NASA, a list of suggested metropolitan areas was included. From this list seven metropolitan areas which met the population size and growth criteria were selected. They were:

Table IV-1 - SMSA Population Size

	1978 SMSA POPULATION (MILLIONS)
ATLANTA	1.8
DENVER	1.5
PHOENIX	1.3
SAN ANTONIO	1.0
SAN DIEGO	1.7
SEATTLE	1.4
TULSA	0.6

Source: 1978 Rand McNally United States Atlas

The Chambers of Commerce of these seven metropolitan areas were contacted for economic and demographic statistics, and this information used in conjunction with the criteria reduced the number of candidate metropolitan areas to four -- Denver, Phoenix, San Diego and Seattle.

3.B.2 Comparison of Candidates

To allow for a detailed comparison of the four candidate metropolitan areas a matrix was constructed (Tables IV-2 and IV-3). The key items of evaluation on these tables were:

- population growth rate
- rate of unemployment
- median age

Table IV-2

Comparison of Candidate Metro Areas
Demographic Profile

	San Diego	Seattle	Phoenix	Denver
Population (1977) (M)	1.7	1.4	1.4	1.6
Population Growth Rate (%/Yr)	2.4	0.6	3.3	1.3
Number Employed	634,000	719,000	518,000	604,000
Unemployment Rate	10.4	7.1	6.7	5.6
Retail Sales ($B)	6.8	4.7	5.0	8.3
Retail Sales/No. Employed	$ 10,725	$ 6,536	$ 9,653	$ 13,742
Median Household Income	$ 13,618	$ 15,022	$ 14,011	$ 16,465
Median Age	28.0	29.5	27.1	26.4
Number Of Telephones	1,361,332	1,198,500	989,965	721,474
No. Telephones/Capita	0.80	0.86	0.71	0.45
Installed Value of Computers ($M)	197	300	190	412

Table IV-3

Comparison of Candidate Metro Areas
Industry Profile

	San Diego	Seattle	Phoenix	Denver
Fortune 500 Companies Headquartered	0	3	2	2
Top 50 Banks Headquartered	0	2	1	0
Top 50 Diversified Financial Headquartered	2	1	1	0
Top 50 Retail Headquartered	1	0	0	0
Top 50 Transportation Headquartered	1	0	0	2
Total	4	6	4	4
Number of TV Stations	4	5	6	5
Number of Radio Stations	21	51	34	13
Number of Newspapers	2	2	2	2
Number of Colleges/Universities	5	3	4	3

- number of telephones/capita
- number of Fortune 500 and Fortune 50 companies headquartered
- number of television stations
- number of radio stations

Based upon this matrix comparison and the criteria for selection which had been established, Seattle and San Diego were eliminated from further consideration.

Seattle was eliminated as a possible metropolitan area because:

- It did not appear to have a sufficient diversity of industry representation, being particularly dependent on the aerospace industry.
- The population of the Seattle SMSA has been growing at a rate of only 0.6% per year. Within the city limits, the population has been declining, and this downward trend is expected to continue until the mid 1980's.

San Diego was removed from consideration as a candidate metropolitan area because:

- It has consistently had a high unemployment rate, and this high rate is not expected to decline in the near future. San Diego's current unemployment rate is 10.4%, well above the recent national average of 7%. By 1984 San Diego's unemployment rate is forecast to be 9.1%, considerably higher than the 5.5% unemployment rate forecast for the U.S.
- The economy of San Diego has a heavy dependence on the military. The number of military personnel in the San Diego metropolitan area represents 11% of the total population of 1.7 million.
- San Diego is only 125 miles south of Los Angeles, a very large metropolitan area. Due to the proximity of the two, San Diego sometimes has to share, among other things, telecommunications facilities. Furthermore, over the next 20 years, as Los Angeles expands and San Diego grows northward, the two will (probably) become even more closely linked.

3.C FINAL SELECTION OF METROPOLITAN AREA

The final selection of Phoenix as the metropolitan area to be studied in depth came about not because Denver would not have been a good choice, but rather because it was felt that Phoenix had a few demographics in its favor relative to the study to be undertaken.

Some of the reasons for the selection of Phoenix are as follows:

- Phoenix's annual population growth rate of 3.3% is significantly higher than Denver's annual rate of 1.3%. This higher rate is expected to continue for the next twenty years. By 1985 Phoenix's population will surpass that of Denver's.

- Phoenix has a diversified representation of industrial companies with 500 or more employees. In recent years it has attracted a large number of companies from a variety of industry classifications. Included are such companies as Motorola, Digital Equipment Corporation, American Express, and Sentry Insurance.

- There is a large number of industrial parks located in the Phoenix area. Since local traffic patterns are of particular interest for this study, the existence of a significant number of industrial parks was an important consideration.

- Phoenix is acknowledged to be the financial center of the southwest. Several large banking institutions are located in Phoenix, including Valley National Bank which is one of the nation's fifty largest banks.

- Population shifts toward the southwest are expected to continue through the 1990's. Phoenix's stature will grow with the passing years, becoming the communications center of the entire region, similar to the position enjoyed by Atlanta today in the southeast.

- Denver, unlike Phoenix. is a major Bell switch city. making it atypical of other United States cities. There are only eight national Class 1 switch cities located throughout the country.

- Finally, the Chamber of Commerce was very cooperative in providing information about their city and promised their support of the project should Phoenix be selected.

4.0 METHODOLOGY

The methodology employed for Task 4 can be subdivided into primary and secondary market research. This section describes the market research design and discusses in detail the primary and secondary data collection procedure. The data tabulation and analysis procedures will be discussed in greater detail in the next section.

4.A PRIMARY MARKET RESEARCH

Primary market research efforts collected data from telecommunications users in the Phoenix Metropolitan area using a personal interview survey format. The research design consisted of the following steps:

1) Preparing a list of needed information

2) Preparing a list of interview candidates

3) Designing a questionnaire to be used for data collection

4) Making a presentation to the Phoenix Chamber of Commerce

5) Scheduling and conducting of in-person interviews

6) Tabulating and analyzing collected data (primary and secondary)

7) Formulating results and conclusions of study

Steps 1 through 5 are discussed in detail in this section.

4.A.1 List of Needed Information

A list was prepared consisting of information that was needed to attain the objectives of this study. The list was used to determine the sources of data required to provide the needed information and to anticipate the limitations in collecting such data. Each item of information was to serve as a guideline in designing the questionnaire used to collect the data. Needed information included:

- Flow of telecommunications traffic between Phoenix and cities outside the Phoenix metropolitan area
- Local telecommunications traffic patterns within the Phoenix metropolitan area
- Estimates of telecommunications expenditures and its distribution among data, voice, and video services
- Distribution of data transmission speeds for 1978, 1980, 1990 and 2000.
- Present and planned use of earth stations, fiber optics, high speed data, electronic mail services, and videoconferencing
- Total number of equipment in use: word processors, data terminals, computers, facsimile terminals, and telephones.

4.A.2 List of Interview Candidates

Candidates were selected to take part in the personal interview survey using the following guidelines:

- The candidates should collectively be geographically dispersed throughout the Phoenix metropolitan area. This would minimize

geographic bias and ensure a sample that would be representative of the area.

- Each candidate should have at least 250 employees. Smaller organizations would tend to have less insignificant telecommunications traffic requirements and could bias the sample because the data could not be properly tabulated. Most of the selected candidates had, in fact, over 500 employees.

- The distribution of selected candidates was designed to conform with a nationwide distribution of communications expenditures by industry. Thus, industries which had greater expenditures than others had a proportionately larger representation on the candidate list.

The number of interview candidates were limited by time constraints placed upon the study. Conformation to the nationwide distribution was dependent on the industrial make-up of Phoenix and its surrounding area. The actual number of organizations for several industry categories (Banking, Insurance, Utilities, and Government) located within Phoenix determined the upper limits of the sample size. Results of the survey verified the validity of the sample through comparison with other documented market data (e.g., Western Union databases and consultant reports).

4.A.3 Questionnaire Design

The questionnaire used during the survey was designed to collect data which would be useful in providing the information listed in Section 4.A.1 of this report. In addition, several specific questions were prepared for representatives from the utilities and services industry sectors.

Questions were prepared to elicit accurate and complete answers from the respondents. The length of the questionnaire was designed to allow the interviewer to complete the visit within a targeted 90 minute timeframe. Some interviews were longer than expected and required a second visit to complete the questionnaire. Each question was pretested prior to the actual interviews to eliminate leading, ambiguous, or intimidating questions.

4.A.4 Presentation to Chamber of Commerce

A presentation was made to the Phoenix Chamber of Commerce to facilitate the interview process. There were several advantages to be gained through such a presentation. Many of the organizations on the interview candidate list, as Chamber members, were informed as to the nature of the study. Arranging personal interviews was facilitated through organizational contacts made at the presentation.

Board members of the Chamber strongly supported the study at the presentation made on November 17, 1978, and provided valuable assistance in arranging the personal interviews.

4.A.5 Scheduling and Conducting of Interviews

Each personal interview was arranged via a telephone call to the contact within the organization to be interviewed. During the telephone call a brief synopsis of the NASA Study was given, followed by a more thorough explanation of the metropolitan area study.

Personal interviews were each conducted by one individual and lasted from 60 to 90 minutes. In most cases the person interviewed was the Director of Communications for the organization, but the title of the individual ranged from Company President to Chief Engineer. Excellent cooperation was received from those who were interviewed, and it was apparent that an attempt was made to answer the questions as accurately and thoroughly as possible.

4.A.6 Tabulation and Analysis of Data

Although discussed in detail elsewhere in this study (Computer Modelling Effort Section), it is necessary to present a brief overview of the tabulation and analysis procedures. Data were tabulated and analyzed using Western Union computer facilities. All work was performed in-house. Data analysis consisted of statistical summaries, percentage calculations, cross tabulations, and mathematical manipulation of numbers.

4.A.7 Survey Results and Conclusions

The results and conclusions drawn from the survey will each be discussed in detail in Sections 6 and 7, respectively. Results were presented in several formats: descriptive summaries; tables; graphs; and mappings. All significant findings were included for the presentation. Conclusions drawn from the survey results were carefully reviewed to verify that the objectives of the study were attained. Areas of interest that are discussed include Phoenix's inter/intra city telecommunications traffic patterns, user requirements, and projected service demand estimates.

4.B SECONDARY MARKET RESEARCH

Secondary market data were collected to complement the data generated by the primary market research procedure. A list of needed information was prepared and potential sources of data providing such information were determined. Required data fell into one of several categories: local Phoenix telecommunications traffic; telecommunications user requirements; and Phoenix demographics. Data were analyzed, and used in conjunction with the processed survey data.

4.B.1 Local Telecommunications Traffic

Although the personal interview survey provided much data on the local telecommunications traffic in Phoenix, there was some information that was still lacking. For this reason visits were made to Mountain Bell, Western Telecommunications Inc. and the Arizona Corporation Council.

Mountain Bell provided a map displaying the Phoenix metropolitan area exchange boundaries and the locations of Bell offices in the Phoenix metro area. In addition, Mountain Bell supplied historical data on the growth of exchanges in the Phoenix metropolitan area. Insights were provided on the telephone usage pattern of Phoenix's residents and peak busy hours were identified.

A meeting held with Western Telecommunications Corporation (WTCI) identified common carrier microwave systems operating in the Phoenix metro area at the 2, 4, 6, and 11 GHz frequencies. WTCI was also able to supply a list of earth stations currently in use in the Phoenix metropolitan area, and a list of those who have applied for licenses.

Compucon was selected to identify the private microwave systems operating in the Phoenix metro area at the 2, 6, and 12 GHz frequency bands.

A meeting was held with the Arizona Corporation Council, the State regulatory agency. However, little information beyond what was received from Mountain Bell could be provided.

Internal sources within Western Union Telegraph Co. were tapped to secure additional indicators of concentrations of telecommunications traffic in the Phoenix metropolitan area. Databases containing the locations of TWX/Telex and WU Private Wire customers in the Phoenix metro area yielded the needed information.

4.B.2 Telecommunications Market

Telecommunications user requirements and market demand estimates were reviewed for relevant data pertaining to this study. Information sources were divided into three categories: industry periodicals; consulting firms; and Western Union databases. Typical industry periodicals were <u>Data Communications</u>, <u>Communications News</u>, <u>Telecommunications</u>, and <u>Electronic News</u>. Consultant reports which were referenced included studies by Quantum Science, International Resource Development, Frost & Sullivan, International Data Corporation, Yankee Group, Input, and A.D. Little.

Market demand data for services provided by Western Union were obtained from internal databases. Prior Western Union studies also were used to contribute to the data collection process.

4.B.3 Demographic Data

Demographic statistics of the Phoenix Metropolitan area were gathered through visits to a number of sources, including Phoenix Newspapers, Valley National Bank, the Arizona Corporation Council, and real estate developers. Government documents were consulted for U.S. Census Bureau statistics. A partial listing of the printed materials used to construct a demographic profile included Inside Phoenix, Arizona Statistical Review, Valley National Bank's Arizona Progress, The Directory of Arizona Manufacturers, and Statistical Abstract of the United States.

5.0 COMPUTER MODELLING EFFORT

The data collected during the interview process were tabulated and analyzed using Western Union's timesharing system. All programming and analysis was performed in-house by Western Union personnel.

Several computer algorithms were used during the analysis. A brief description of the software documented exclusively for this study will include the types of data records set up, size of fields, and analysis examples taken directly from the project.

5.A DESCRIPTION

The data collected during the interview process underwent several procedures before a final printout of desired results could be obtained. In chronological order, the steps included an editing, a coding, a tabulation, and an analysis phase. The primary purposes of editing and coding were to eliminate errors in the raw data and to process the data into categories for tabulation purposes.

Editing the raw data checked for the following: adherence to sampling instruction; legibility of recorded data; completeness of answers; consistency; and understandability. Editing detected incorrect answers and reconciled incomplete answers (e.g., distinguishing between a response of "0" and a non-response).

The coding process established categories for each of the responses to a particular question. This process insured that each category's possible responses fell into unambiguous and nonoverlapping groups. Coded data were then tabulated by computer.

The coding process established categories of responses which could be entered onto the computer files using an on-line terminal. Several files were created to store the coded data; each file was a collection of several records. Record codes were established for data access, manipulation, and updating. Within each data file there were three commonly used records: data, label, and trailer records. A variable-variable physical and logical data record relationship was used (i.e., length of physical records and logical records vary in size within the file). Records were organized sequentially in the files.

There were twenty-eight physical records per file, corresponding to the twenty-eight survey respondents. Each record was coded with the appropriate corporate ID. Besides data traffic, voice traffic was also included on the same file. Other file information included telecommunications expenditures, traffic destinations, equipment use, operating speeds, applications of equipment, etc.

5.B BASIC ALGORITHMS

The computer tabulation and analysis was based on several algorithms. Tabulation of data included sorting, counting, and summarizing of results. These functions were applied to every category of data. After tabulation, the analysis was performed. Summary statistics provided by the software included the mean, the median, the range, and percentages. Cross tabulation was performed on selected groups of data. Mathematical manipulation of tabulated data was used in several cases.

Examples of the analysis performed included: finding the mean projected growth rate of annual telecommunications expenditures, the percentage of respondents planning to install earth stations, the distribution of voice switches in the Phoenix-SMSA, and the calculation of data traffic volume using raw data for transmission speed, number of terminals, and operating hours for selected SMSA's. The last calculation involves a cross tabulation of SMSA's by data volume. Data volume was determined by multiplying the raw data and using a form of dimensional analysis.

6.0 PRESENTATION OF RESULTS

Results of the market research analysis are presented in the form of descriptive summaries, tables, charts, and mappings. Included in the presentation are: a framework for results; displays of traffic in and out of Phoenix; and primary and secondary market research findings. Each section of the report documents the major findings of the study, summarizing the mass of data gathered throughout the research and analysis processes.

6.A FRAMEWORK FOR RESULTS

An economic and demographic overview of the Phoenix metropolitan area was prepared and is included in this report for a clearer perspective of the preceding results. Basic economic indicators and population trends for Phoenix and the surrounding area are displayed. Manufacturing output and employment figures are also included.

A summary table with the percentage distribution of completed interviews by SIC code is contrasted against nationwide estimates for annual communications expenditures.

The metropolitan area of Phoenix and Maricopa County are considered the same for purposes of this report, and includes the cities of Phoenix, Scottsdale, Mesa, Tempe, Glendale, Chandler and Sun City.

6.A.1 Economic Criteria and Trends

Several indicators of economic growth are displayed in Table IV-4.

Table IV-4 - Demographic Profile: Phoenix-SMSA

	1967	1977	% Change
Population	890,000	1,300,000	+ 46.1%
Retail Sales	$1,615,267,000	$2,348,500,000	+245.4%
Bank Deposits	$1,578,103,000	$4,820,917,000	+205.5%
Vehicle Registrations	566,561	963,377	+ 71.1%

The financial base of the Phoenix metropolitan area, measured by bank deposits and retail sales, increased over 200% between 1967 and 1977. This was more than four times the increase in population during the same period. A substantial increase was recorded for vehicle registrations, also outpacing the population increase.

Manufacturing output, measured in terms of value added, more than doubled between 1970 and 1977; present estimates are over $3 billion. Despite erratic growth periods (1970-1971 and 1974-1975), the trend within the past five years indicates steady increased growth.

6.A.2 Population Trends and Employment

The population of the city of Phoenix has increased tenfold since 1940. Population growth has not been confined within the city limits, however. Maricopa County's population has doubled since 1960. There are several major cities in the Phoenix-SMSA region, excluding Phoenix (Table IV-5). Each of these cities has doubled their population since 1970.

Table IV-5 - Population: Major Cities in Phoenix - SMSA

City	Population (1977)
Phoenix	682,200
Mesa	115,000
Tempe	103,000
Scottsdale	82,000
Glendale	75,175
Sun City	43,500

A distribution of employees within the major business sector in Phoenix is as follows:

Table IV-6 - Employment: Phoenix - SMSA

Industry	Employees (As of June 1978)
Manufacturing	88,500
Mining	600
Construction	38,600
Transp. & Utilities	27,000
Whlse. & Retail Trade	132,800
Fin., Ins. & R.E.	36,100
Services & Misc.	95,900
Government	91,400
Total	510,900

Forty percent of the work force is concentrated in two sectors: wholesale and retail trades, and manufacturing. Construction has been the fastest growing sector for the last few years.

6.A.3 Distribution of Interviews

The distribution of completed interviews is shown in Table IV-7. This is contrasted against a nationwide distribution of communications expenditures by SIC code. Interviews were arranged to correlate with the communications expenditures distribution.

6.B DISPLAY OF TRAFFIC BETWEEN PHOENIX AND OTHER METROPOLITAN AREAS

Metropolitan areas with significant telecommunications traffic originating from Phoenix were analyzed. Survey results of areas with multiple mentions are presented as well as data traffic volume for each location. Private microwave transmission traffic was analyzed using secondary research data. Information pertaining to dedicated trunks was obtained through the survey questionnaire and those cities mentioned as having dedicated lines to Phoenix are included in the report. Lists and/or mappings are displayed for each of the above areas of information. A display of zip code areas in the Phoenix metro area is shown in Figure IV-1.

Table IV-7 Industry Distribution of Interviews

Industry	Number Of Interviews	Percentage Of Interviews	Nationwide Distribution Of Comm. Expend.
Manufacturing	10	32	43
Transportation	-	-	5
Utilities	3	9	5
Wholesale	-	-	6
Retail	1	3	6
Banking/Financing	5	16	10
Insurance	2	6	6
Medical/Health Services	1	3	4
Education	1	3	2
Misc. Services	6	19	16
Government	3	9	-
	32	100%	100%

Metropolitan Phoenix: Zip Code Map

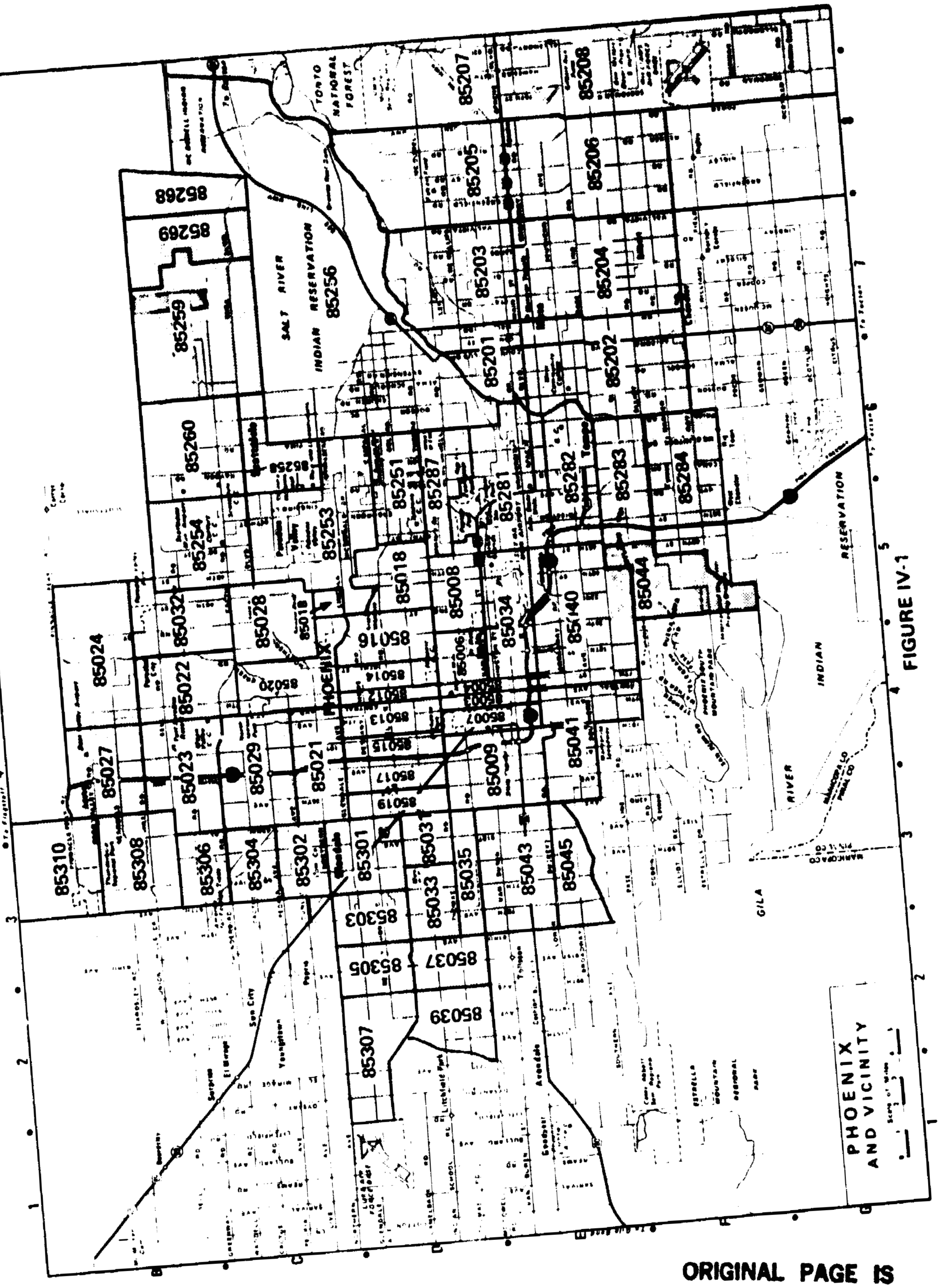


FIGURE IV-1

ORIGINAL PAGE IS OF POOR QUALITY

6.B.1 Telecommunications Traffic Outside Phoenix

Locations, by SMSA, outside of Phoenix with significant telecommunications (voice and/or data) traffic are displayed below:

Table IV-8 - Major Traffic Outside Metro Phoenix

SMSA	CITY	NUMBER OF MENTIONS
4480	Los Angeles - Long Beach, CA	19
5600	New York, NY - NJ	16
8520	Tucson, AZ	15
1600	Chicago, IL	12
1920	Dallas - Ft. Worth, TX	8
2080	Denver - Boulder, CO	8
520	Atlanta, GA	7
200	Albuquerque, NM	6
7320	San Diego, CA	6
5120	Minneapolis - St. Paul, MN - WI	5
7360	San Francisco - Oakland, CA	5
8840	Washington, DC - MD	5
3360	Houston, TX	4

Only locations with multiple survey mentions (four or more) are included. The major cities outside of Phoenix with the most mentions were Los Angeles, New York, and Chicago. Three cities in the state of Arizona were among those cited: Tucson; Flagstaff; and Yuma. Many of the locations are within a thousand mile radius of Phoenix. Six of the nation's ten largest SMSA's are included on the list.

6.B.2 Data Traffic Volume

Table IV-9 lists locations with significant data volume, in descending order. Volume was calculated using survey data for transmission speeds, number of terminals in operation, and transmission hours per day per terminal. The majority of data traffic remains within the Phoenix area.

Table IV-9 - Data Traffic Volume

SMSA	CITY	DAILY VOLUME (BITS)	NUMBER OF MENTIONS
6200	Phoenix, AZ	8430150	35
8520	Tucson, AZ	2410600	15
4480	Los Angeles - Long Beach, CA	620100	19
5120	Minneapolis - St. Paul, MN - WI	355275	5
4920	Memphis, TN - AR	307200	1
520	Atlanta, GA	273825	7
5920	Omaha, NE - IA	230400	1
9240	Worcester, MA	153600	1
1600	Chicago, IL	146500	12
5600	New York, NY - NJ	131500	16
6720	Reno, NV	86400	3
1840	Columbus, OH	76800	1
80	Akron, OH	67200	1
4120	Las Vegas, NV	58200	2
1120	Boston, MA	57600	3
8840	Washington, DC - MD	49050	5
7360	San Francisco - Oakland, CA	48075	5
640	Austin, TX	46900	2
1920	Dallas - Fort Worth, TX	42175	8
360	Anaheim - Santa Ana - Garden, CA	38400	1
2080	Denver - Boulder, CO	38400	8
4360	Lincoln, NE	38400	1
6760	Richmond, VA	38400	1

Excluding cities with a single mention, Los Angeles, Minneapolis-St. Paul, Chicago, and New York have the most data traffic originating from Phoenix. San Diego and Albuquerque, which were included in Table IV-8 are noticeably missing from the list, indicating that there is significant voice but little data traffic between them and Phoenix. The sampling process was one of the factors which determined data traffic destinations. Most of the data traffic originating within Phoenix and remaining within Arizona was generated by utility companies and government agencies.

6.B.3 Microwave Transmission

Both the common carrier and private microwave networks operating in an area which includes Phoenix, Flagstaff and Tucson were identified and analyzed.

The common carrier microwave networks (Figure IV-2) were those operating at the 2, 4, 6 and 11 GHz frequencies. They included systems being operated by AT&T, Mountain Bell, WTCI, MCI, SPCC and Western Union. As might be expected, the main corridors for these systems link Phoenix with Los Angeles, Tucson, Flagstaff, Mesa and Tempe.

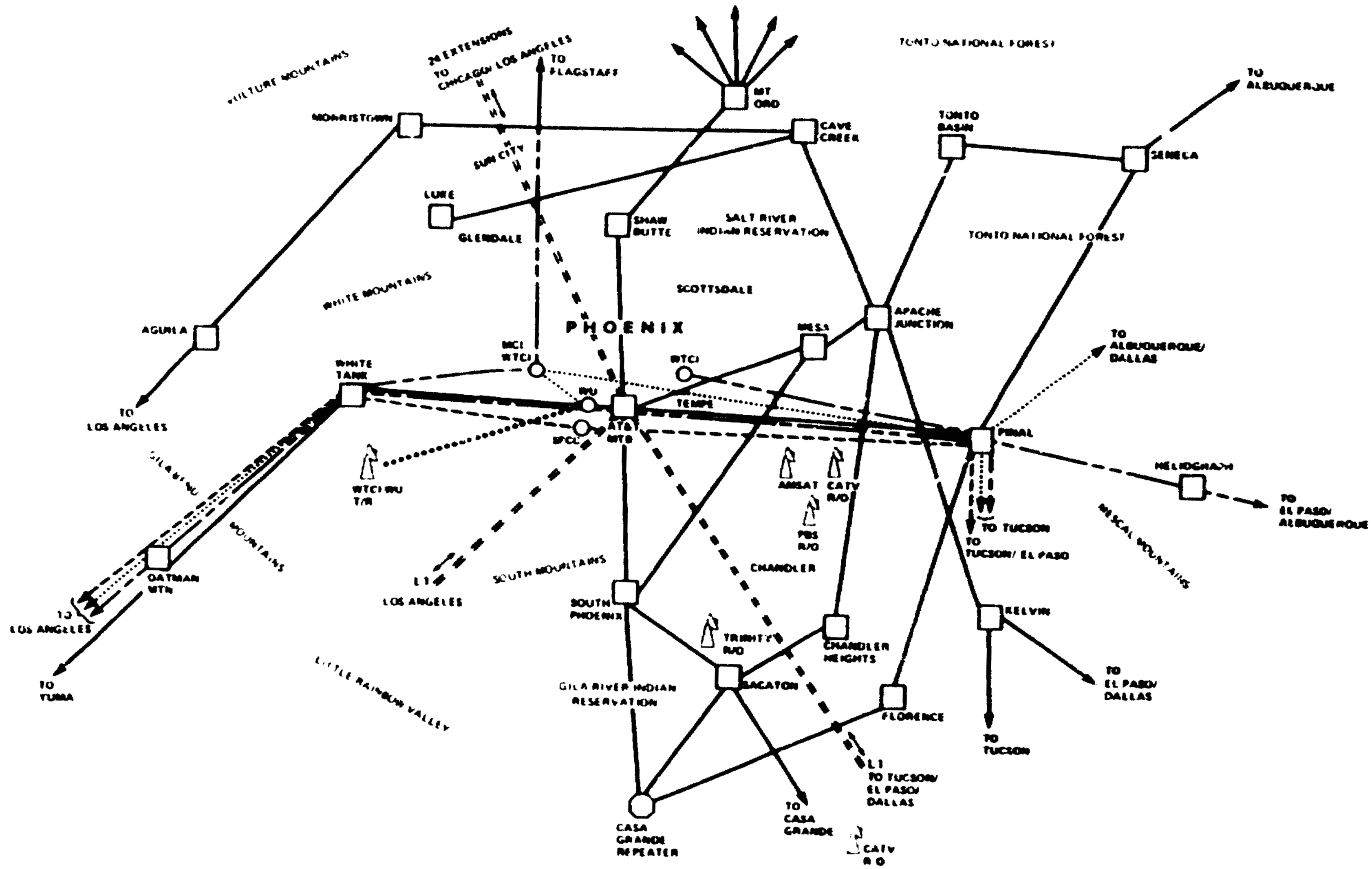
Compucon, Inc. was contracted to provide maps of private microwave systems operating at the 2, 6, and 12 GHz frequencies. The most dense traffic in Arizona for these frequencies is centered around Phoenix, Flagstaff and Tucson. The majority of long haul links are to either Los Angeles or Albuquerque, New Mexico. Figure IV-3 is an illustration of the 6 GHz traffic. There are few microwave systems operating at the 12 GHz frequency. This band is only lightly used in most areas of the country. About 50% of the 12 GHz band is still available, but usage will increase due to congestion on the 2 GHz and 6 GHz bands.

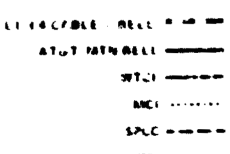
6.B.4 Voice Traffic

The survey sample revealed that only five cities had dedicated voice private line trunks connecting them to Phoenix. Not surprisingly, Tucson had 79 trunks. For areas outside Arizona, two cities had a significant number, Los Angeles (19) and Albuquerque (9). Both of these cities are located relatively close to Phoenix, 370 miles and 340 miles, respectively.

The analysis of the survey data calculated a total of 201 WATS lines among the respondents. A large percentage of these WATS lines, 82%, were interstate band WATS lines. The remaining were divided among WATS band 3 and band 9 lines.

As a part of the Bell network, Phoenix is a Class 2 office and homes in on San Bernardino, CA as its primary routing center with Denver and Dallas as secondary routing centers. Bell has recently installed 2 switches in Phoenix, one a 40,000 line ESS-1 and the other a 10,000 line 4A crossbar switch. Bell has a total of 25,000 circuits coming into Phoenix. Of this total, four (4) are video channels, leaving 20,400 circuits to be divided between voice and data channels.





COMMON CARRIER MICROWAVE AND EARTH STATION LOCATIONS IN PHEONIX

FIGURE IV-2

6 GHz Operational Fixed Band

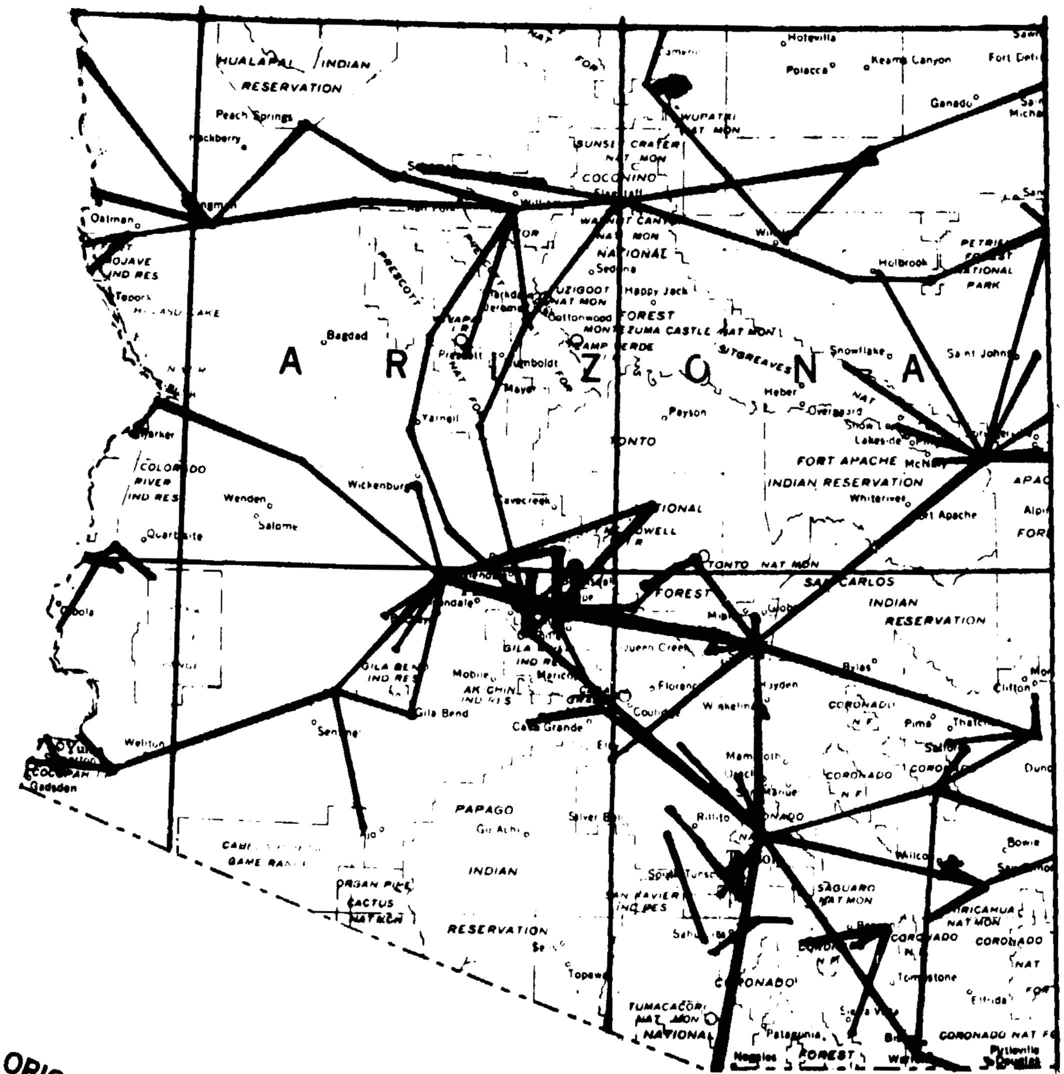


FIGURE IV-3

Mesa is a Class 4 central office and serves as an AT&T Long Lines switching office. Tucson is also a Class 4 office. Denver, by comparison, has five (5) 4A crossbar switches and an ESS-4 switch. The Colorado capital has twice as many circuits (40,000) as Phoenix, and has direct international traffic to the Pacific. Denver is also one of eight regional centers in the United States which are used by AT&T for primary routing.

6.C DISPLAY OF LOCAL PHOENIX TRAFFIC

Local Phoenix traffic was analyzed from data collected through surveys, market research reports, Mountain Bell sources, and Western Union's internal databases. Lists and mappings of areas by ZIP codes are included to provide a visual perspective of the results.

6.C.1 Telecommunications Traffic Within Phoenix

ZIP code areas of user locations with significant telecommunications traffic are displayed in Figure IV-4. The originating points of the traffic were dependent to some extent on the sampling procedure.

User identified locations of telecommunications traffic, with multiple mentions during the survey are shown in Figure IV-5. It can be seen that the downtown central corridor along Central Avenue has the heaviest concentration of traffic. This area houses Phoenix's major office buildings. Several industrial parks are within the 85009 area, including those along Black Canyon Highway. Traffic within Tempe is in areas containing industrial parks (e.g., Eaton University Industrial Park and Broadway Industrial Park). In addition, two of the banks interviewed have large DP centers located in Tempe. Several of Phoenix's largest employers operate within the zip code areas listed from the survey.

6.C.2 Computers and Terminals in Phoenix

A computer listing of computers and terminals by zip code for the Phoenix area was obtained from International Data Corporation (IDC). Although the list was not a complete inventory of every computer or terminal in the region, the distribution of units by ZIP code isolates those areas with significant data traffic.

Table IV-10 lists, in descending order, ZIP code areas by the number of large mainframe computers (Class 5-7 by IDC classification). ZIP code 85029 tops the list because of the Honeywell offices. ZIP code 85282, absent from the previous list, has the second highest total of computer mainframes. Several of the area's banks have their processing centers in this Mesa vicinity. There were 73 mainframes, or 37% of all computers, distributed among twenty five ZIP code areas. IDC classifies Class 5-7 computers as capable of supporting remote terminals. Typical examples are IBM 370/145, 148, 155, 158, etc., all Univac 1100 models, all Burroughs B4500 and higher models, and all Honeywell G Models.

Local Phoenix Traffic
User Locations

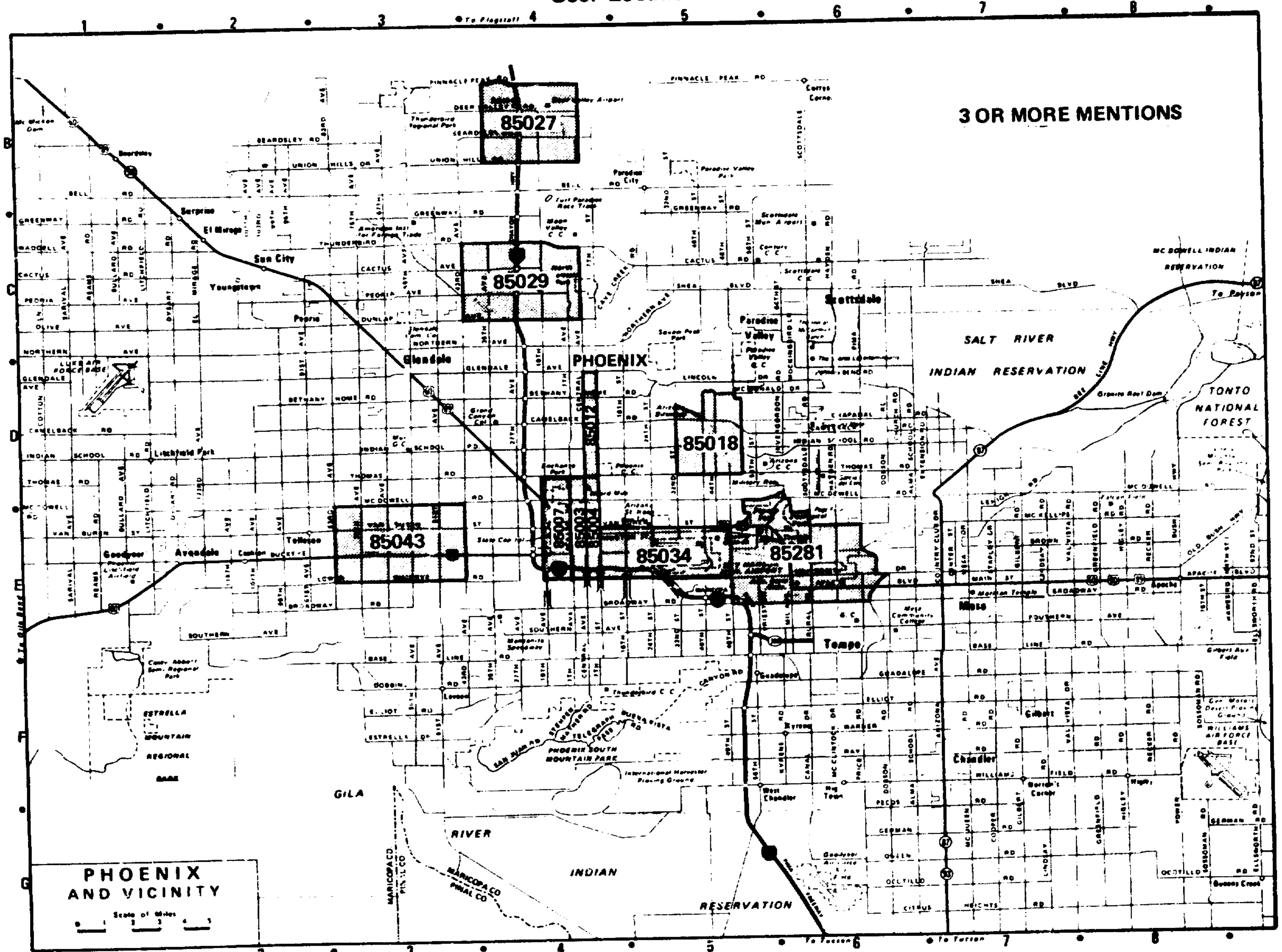


FIGURE IV-4

Local Phoenix Traffic
User Identified Locations

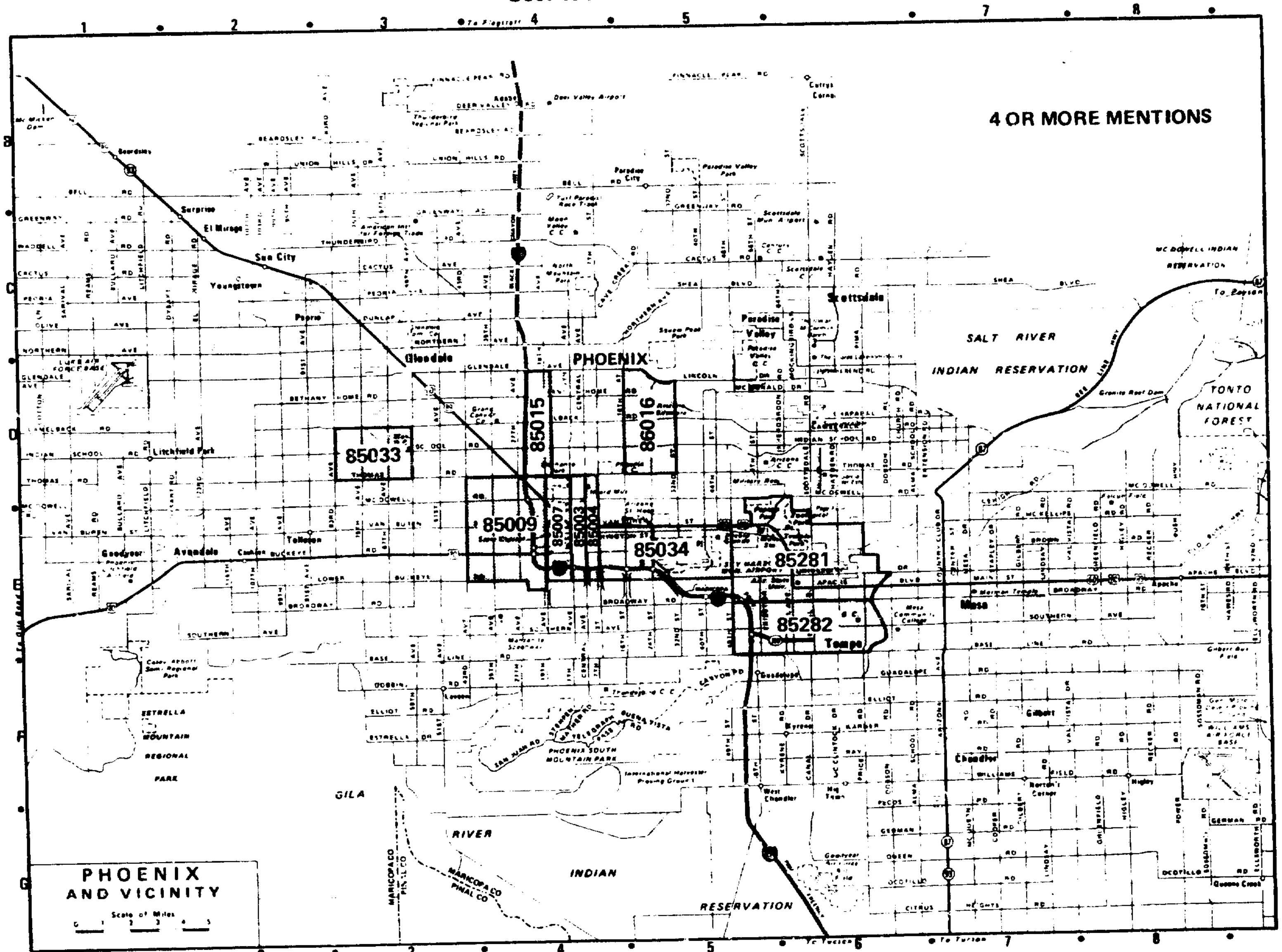


FIGURE IV-5

ORIGINAL PAGE IS OF POOR QUALITY

Table IV-10 - Computers: Class 5-7 IDC* Listings
Phoenix Metro Area

ZIP CODE	NO. COMPUTERS	PERCENT TOTAL
85029	15	20.6
85282	6	8.2
85016	5	6.8
85003	4	5.5
85005	4	5.5
85007	4	5.5
85012	4	5.5
Others	31	42.4
TOTAL	73	100.0

*International Data Corporation

Table IV-11 - Computer Terminals: Class 2-7 IDC* Listings
Phoenix Metro Area

ZIP CODE	NO. TERMINALS	PERCENT TOTAL
85005	437	16.2
85016	355	13.2
85004	245	9.1
85036	220	8.2
85012	205	7.6
85007	183	6.8
85003	137	5.1
85034	134	5.0
85282	126	4.7
Others	655	24.3
TOTAL	2697	100.0

*International Data Corporation

Computer terminals, Table IV-11, are listed by zip code for Phoenix localities. This list indicates a heavy concentration of computer terminals in a select number of areas. Thirty two zip codes accounted for the 2,697 computer terminals in the Phoenix Area.

A summary map of zip code areas with the greatest number of computers and/or terminals is displayed in Figure IV-6. Two zip code areas on the list, 85005 and 85036, are Post Office Boxes. This explains their high totals, especially the 437 terminals located in 85005.

6.C.3 Mountain Bell Network

There are seven Mountain Bell offices established for the Phoenix Metropolitan area (see Figure IV-7). Between 1973 and 1978 the number of telephone exchanges increased 13.4%. The Mesa-Tempe region accounted for more than one third of the increase of exchanges. This statistic emphasizes the significant growth within the Mesa-Tempe area. Each exchange has a capacity of 10,000 telephone numbers. Almost 110,000 new numbers have been established since 1973, of which Mesa-Tempe had approximately 40,000 of the total. The Phoenix office experienced only a slight increase in the number of exchanges during the 1973-1978 period.

Growth of telephone exchanges was a significant indicator of the continual expansion of the residential and industrial populations within the Phoenix metropolitan area. The 13.4% increase of exchanges paralleled the population growth of the seven Mountain Bell office areas, an estimated 17% increase between 1973 and 1978. This figure is based on the average annual growth rate for the years 1970 through 1977. Industrial park developments sharply increased in number, expanding from 39 to 74 complexes within the Phoenix-Tempe-Mesa areas. Two areas of significant population growth, (Tempe and Mesa) also had the largest telephone exchange increases.

Peak busy hours for the Phoenix area, according to sources at Mountain Bell, are 9:00-11:00 a.m. and 6:00-7:00 p.m. The latter hour coincides with lower interstate rates taking effect at six o'clock. Residential telephone volumes comprise a significant portion of total telephone traffic in the Phoenix metro area.

6.C.4 Western Union Network

Western Union's internal databases were analyzed to verify that the ZIP code areas identified from previous data sources were valid locations of significant telecommunications traffic. Specific databases searched were Telex, TWX and Private Wire Service customer lists for the Phoenix area. A distribution of each service by zip code was developed. Zip codes with significant proportions of total terminals or circuits were checked against zip codes listed from survey results and outside data sources. A strong correlation exists between survey results and secondary sources and Western Union Telex/TWX terminal and Private Wire Circuit locations. As an example, zip

Local Phoenix Traffic

Computer/Terminal Installations

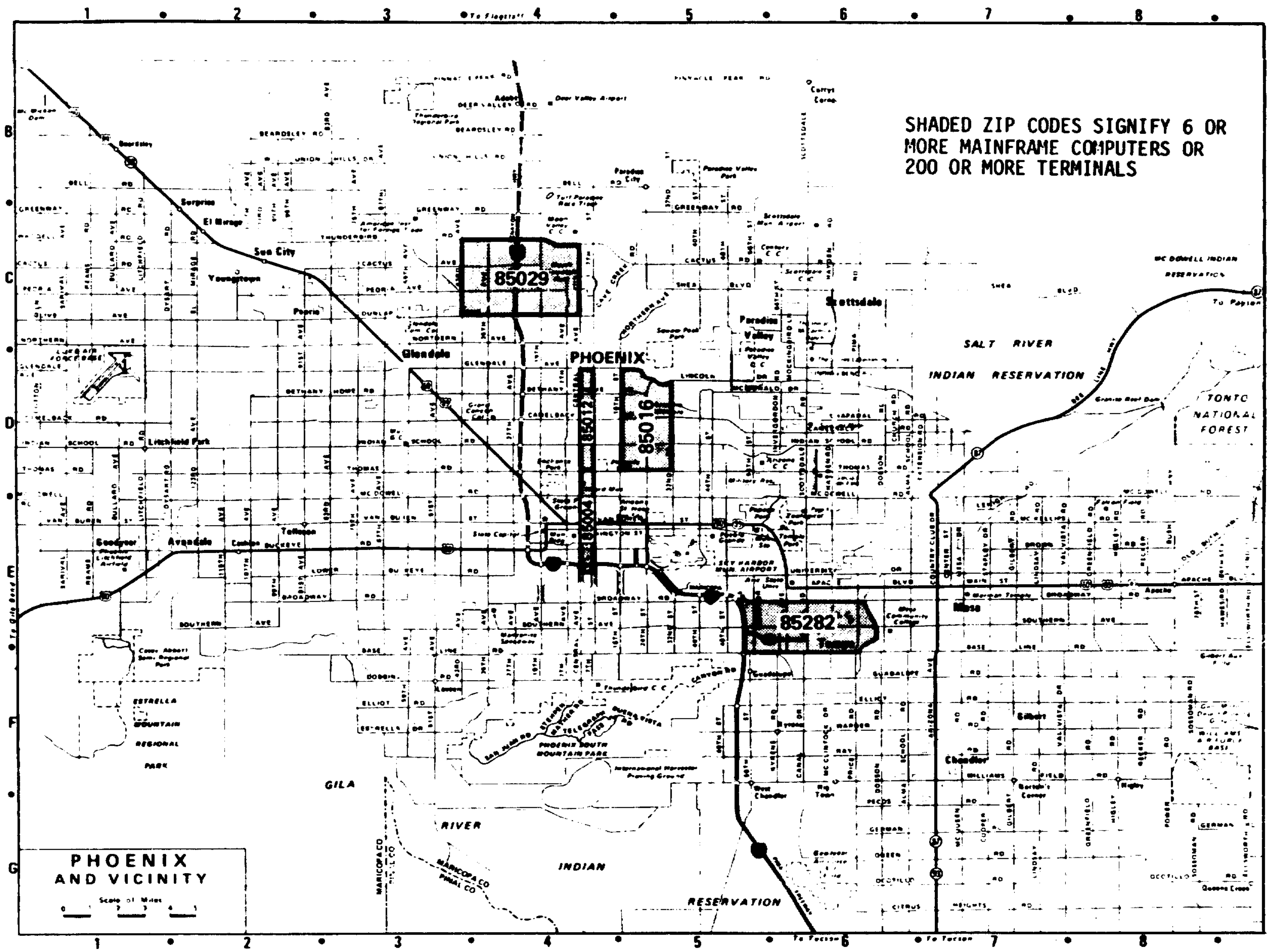
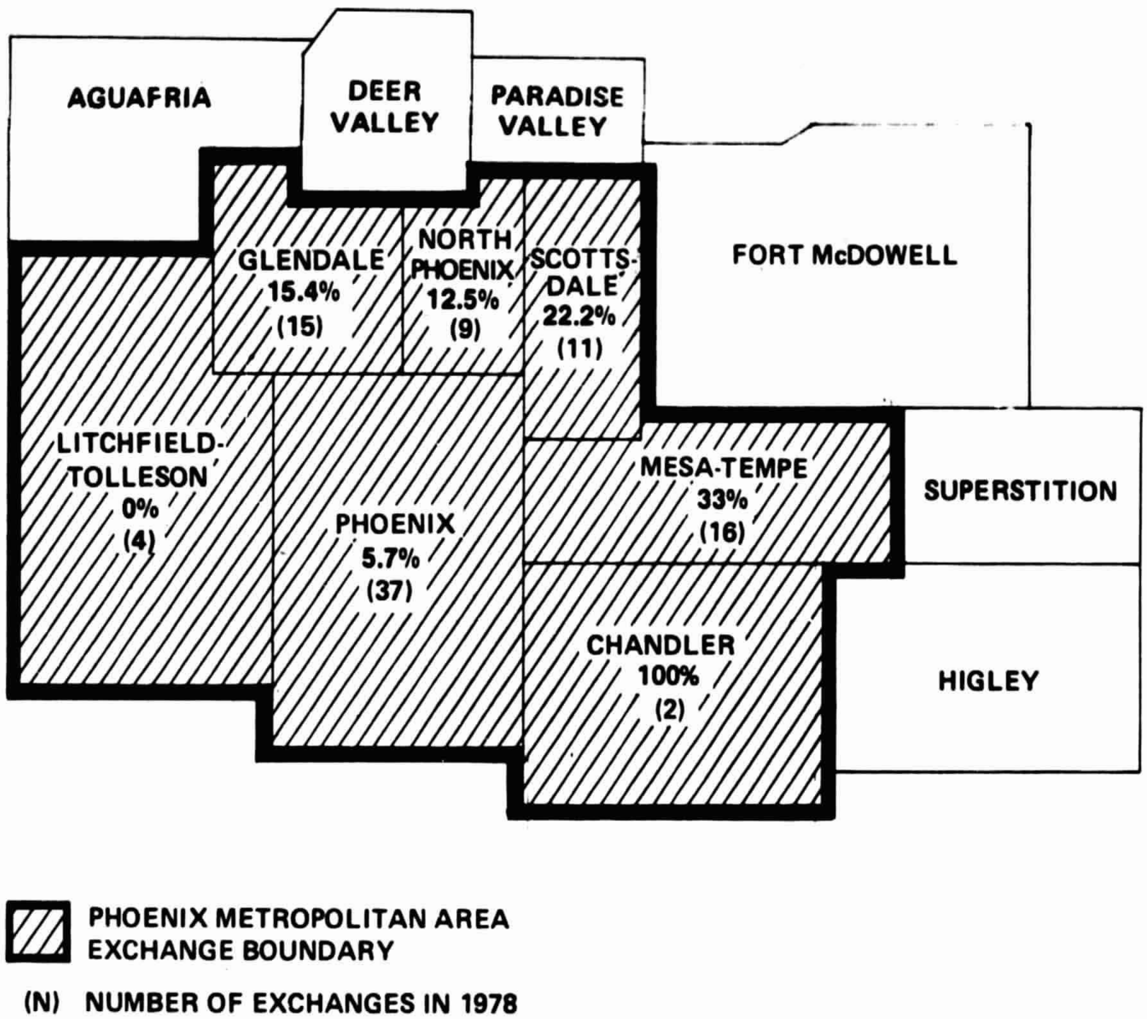


FIGURE IV-6

Phoenix Telephone Exchange Growth



PERCENTAGE GROWTH: 1973-1978

FIGURE IV-7

code area 85004, mentioned in the survey and secondary source findings, also had a high percentage of total Western Union Traffic.

6.D DISTRIBUTION OF SERVICES

An analysis of services used by the respondents to the survey included: annual telecommunications expenditures distributed by type of service; use and applications of transmission facilities and equipment; projections of future service applications; and a discussion of factors affecting the use of services.

Each section of the presentation includes tables and charts which highlight major research findings. All information presented, unless otherwise noted, is based on primary market research data.

6.D.1 Annual Telecommunications Expenditures

The mean and range of annual telecommunications expenditures for those respondents interviewed were calculated at $2 million and $0.1-$12.0 million, respectively. The distribution of expenditures by service was: 78% voice, 18% data and 4% video. Responses for voice ranged from 10% to 90%; for data, 0% to 90%. The responses for voice and data were distributed in a bell shaped curve. The high percentage of video expenditures can be attributed to the responses of the TV and CATV firms.

The percentage growth of total expenditures, the mean and range, was calculated for the past five years and for projections given for the next five years. A consistent growth rate is forecasted. Respondents with low expenditure bases projected higher growth rates than the mean. Growth was smallest for the utilities sector. Each industry sector had individual responses within a narrow range, with only a few noticeable exceptions.

6.D.2 Transmission Facilities

Two transmission facilities presently not in general use were included as part of the survey, earth stations and fiber optic cables. Planned use of each was analyzed and is presented in this report. Installation of earth stations is predicted to be more prevalent than fiber optic cable use.

6.D.2.a Earth Stations

The percentage of respondents planning to install earth stations is 32%. As of this writing, only one respondent has an earth station in service. Most respondents indicated locating their earth stations on rooftops.

There are eight earth stations presently in service within the state of Arizona. Six of the earth stations are located in the Phoenix metro area.

6.D.2.b Fiber Optics

Only 14% of survey respondents have considered using fiber optic transmission. Some of the respondents were not familiar enough with the medium to evaluate it. Sufficient traffic volume was cited as a constraint to its use.

6.D.3 Electronic Mail Services

Electronic mail services, including communicating word processors and high speed facsimile, were covered in the survey and the results of the analysis are presented in this section. A little more than one third of the respondents have studied the feasibility of electronic mail. Less than 10% of present mail volume could be handled electronically according to survey results. Several responses indicated that no mail volume could be handled electronically.

Analysis of communicating word processor applications showed that a very small percentage of word processors are used to communicate with one another. The trend is toward increased communication within the next few years. When word processors do communicate, it is almost exclusively for intracompany applications. Intercompany applications are expected to increase slightly within the next ten years.

High speed facsimile usage is projected to increase sharply within the next five years. By 1983, 50% of the respondents indicated some application of high speed facsimile. The number of pages transmitted per month per company ranged from twenty five to several hundred.

6.D.4 Videoconferencing

More than one half of the respondents expected some usage of videoconferencing by 1990. Business meetings and training sessions were cited as the major applications. Factors affecting the use of videoconferencing were ranked in descending order. Cost, by a wide margin, was cited as the most important factor. The next three factors were closely ranked. Survey respondents indicated that 40% of their anticipated videoconferencing applications could be handled by a combination of audioconferencing and high speed facsimile.

6.D.5 User Equipment

Respondents were queried concerning the type and amount of their communications equipment. On an average, telephones numbered 1239 per respondent, data terminals 215 per respondent, and facsimile terminals totalled 18 per respondent. The most commonly used voice switch was the Centrex II. Almost all the respondents possessed some type of computing facility. Averages per company take into account all Phoenix locations.

6.D.6 User Operating Characteristics

Several key operating characteristics of data and voice transmission were analyzed from survey results, including speed of transmission, allowable time outages, and postponement of traffic to off-peak hours. Some significant trends are apparent in the information presented.

The distribution of transmission speeds at which the respondents presently are operating and plan to operate in the future are seen in Figure IV-8. Current requirements are largely fulfilled by low to medium speed transmission. By 1990, a sharp decrease in low speed transmission will occur, accompanied by a levelling off at 4800 bps and increased use at higher transmission speeds. Most transmission in 1990 will occur within the 4800-9600 bps bandwidth.

High speed applications include real time processing, batch processing, and remote job entry, according to survey results. Only a few respondents are currently operating at high speed.

A distribution of tolerable outages for data and voice transmission indicated that a sizeable proportion of respondents could not tolerate any interruption of services. Users implied that economic incentives could change the proportion of traffic that could be postponed to off-peak hours.

7.0 SIGNIFICANT CONCLUSIONS

This final section is devoted to a presentation and discussion of the significant conclusions of Task 4 and the possible impact on other segments of the market demand study. Part of the presentation is an interpretation of the findings and an evaluation of the factors which influenced the results. Respondents to the survey were not able to make projections through the year 2000 because of uncertainties associated with future plans. Projections through the year 1990 were obtainable in most instances and were analyzed. Secondary sources projected market demands through the year 1988. Estimates beyond the year 1990 were either too vague or unreliable. Technological advances are constantly forcing revisions of previous forecasts. A market scenario of the year 2000, developed by Western Union, based in part on the survey results, is presented to fulfill the task requirements.

The following is a listing of the significant conclusions of Task 4:

- Three metropolitan areas, Los Angeles, New York and Chicago, are the major centers of interstate telecommunications traffic originating from Phoenix.
- Task 4 survey results indicate that there are several areas within Phoenix where local telecommunications traffic is concentrated or where "pockets of communication" exist.

Distribution of Data Transmission Speeds

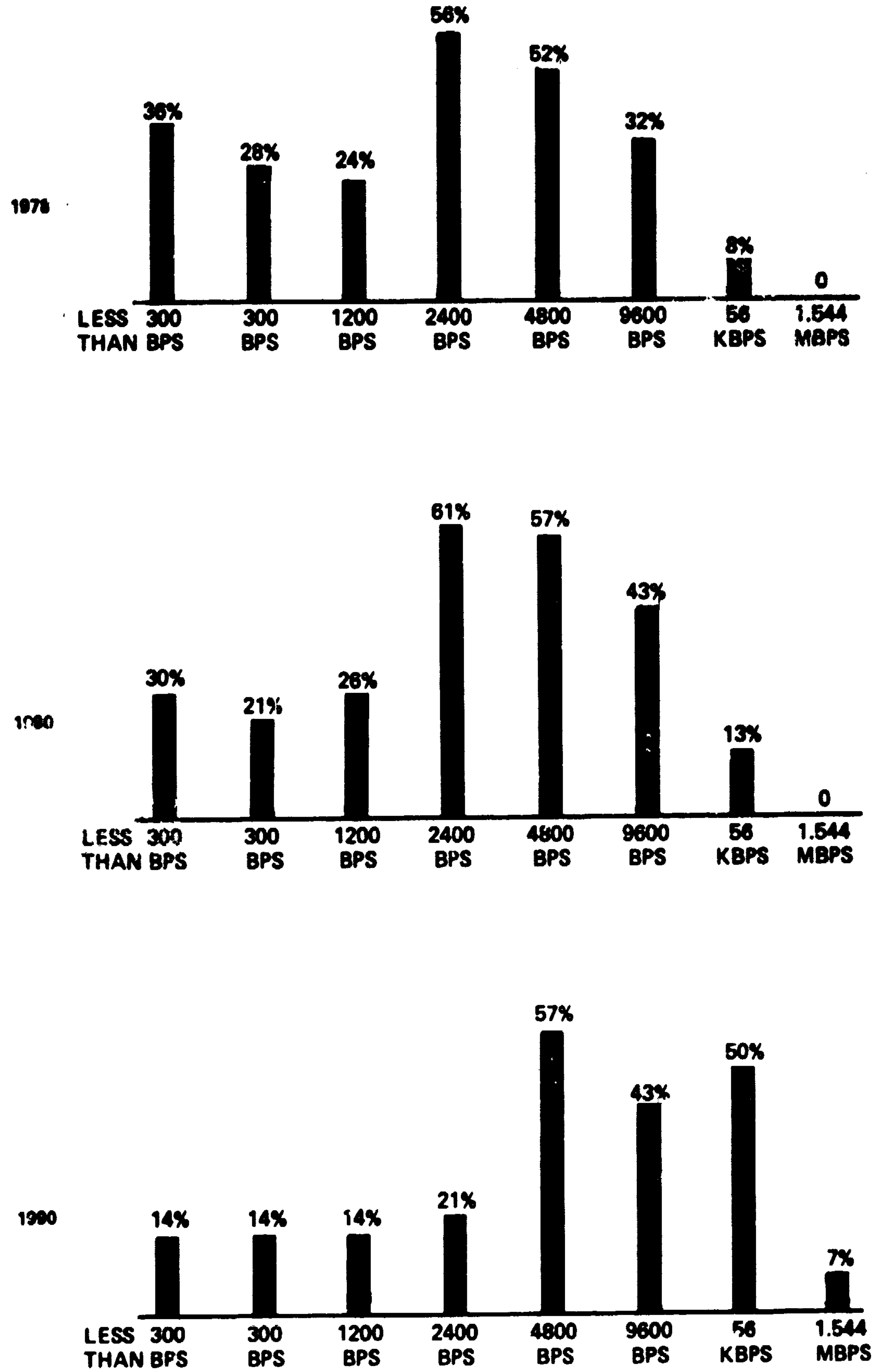


FIGURE IV-8

- Seventy five percent of the total data traffic originating within Phoenix is intrastate or short haul.

- Results of the personal interview survey indicate that of the interstate voice traffic originating from Phoenix, 75% is transmitted over WATS lines.

- Information gathered during Task 4 indicates that videoconferencing use will not become widespread until the late 1980's.

- Approximately one third of those interviewed have considered installing earth stations.

- Survey respondents showed a low level of interest in the application of fiber optics.

- Thirty six percent of the respondents have conducted feasibility studies of electronic mail.

- Telecommunications expenditures are projected to grow an average of 15% to 20% over the next five years.

- Survey data analysis showed a definite trend to higher data transmission speed operation (see Figure IV-9).

7.A INTERPRETATION OF CONCLUSIONS

The occurrence of Los Angeles, New York, and Chicago as the major locations of interstate telecommunications traffic from Phoenix is not surprising since they are the three largest cities in the country. The number one ranking of Los Angeles can be explained by its proximity, 370 miles, to Phoenix. Many of the respondents had either corporate or branch operations in the three cities.

The existence of local concentrations of telecommunications traffic or "pockets of communication" has major significance for the study since this was one of the key objectives of Task 4. Six zip code areas were identified as having substantial telecommunications traffic requirements through an analysis of the personal interview survey data, Western Union databases, and secondary sources for the Phoenix area (Figure IV-10). If Phoenix is representative of other metropolitan areas, the sharing of earth station facilities may be possible at locations where local telecommunications traffic is concentrated.

Survey data showing that 75% of data traffic originating within Phoenix is intrastate or short haul can be attributed to four basic factors:

- Arizona is the sixth largest state in the nation in terms of land area.

- A significant proportion of the respondents, such as banks,

Trend In User Data Transmission Speeds

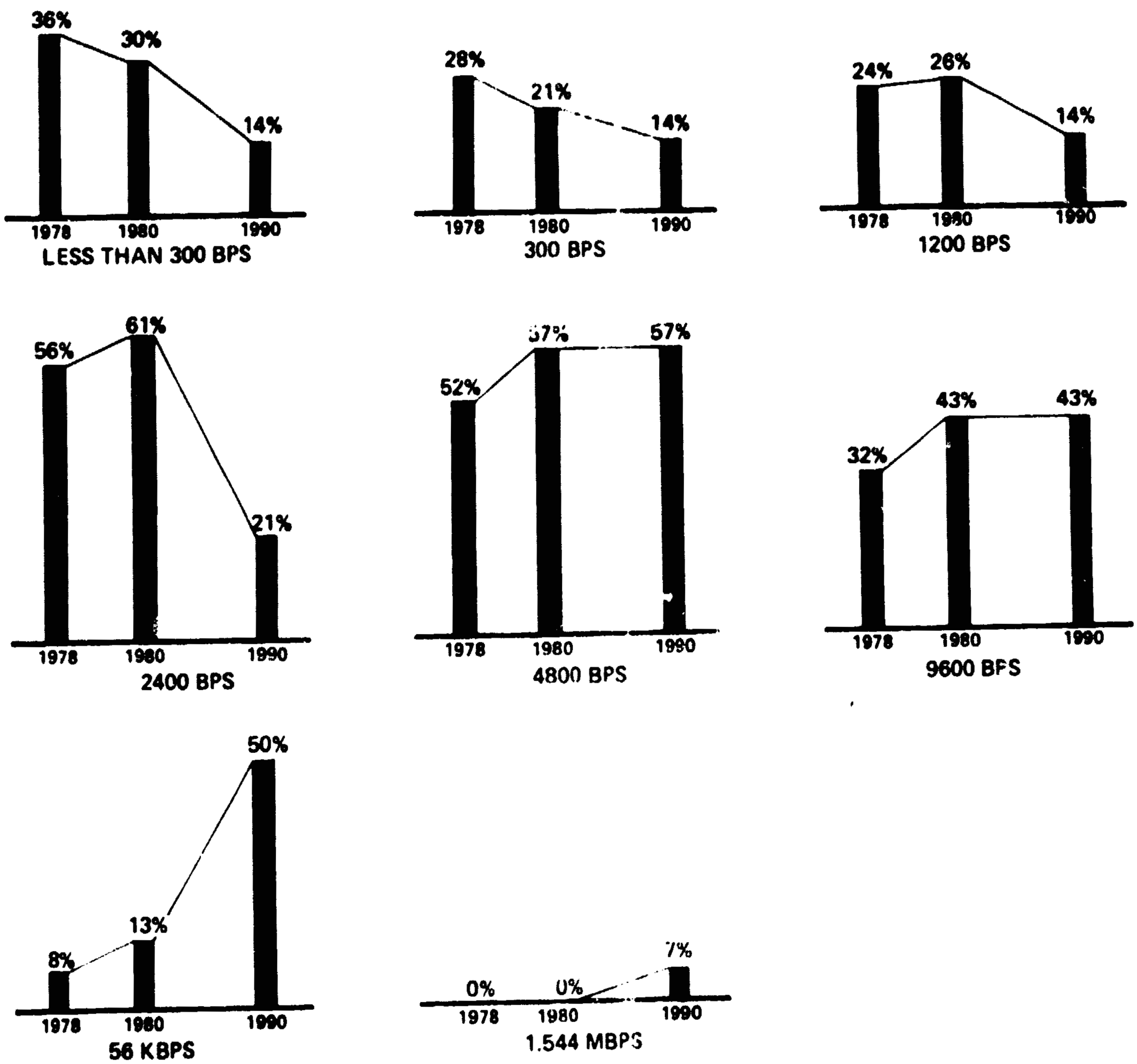


FIGURE IV

Local Phoenix Traffic

Composite of Traffic Indicators

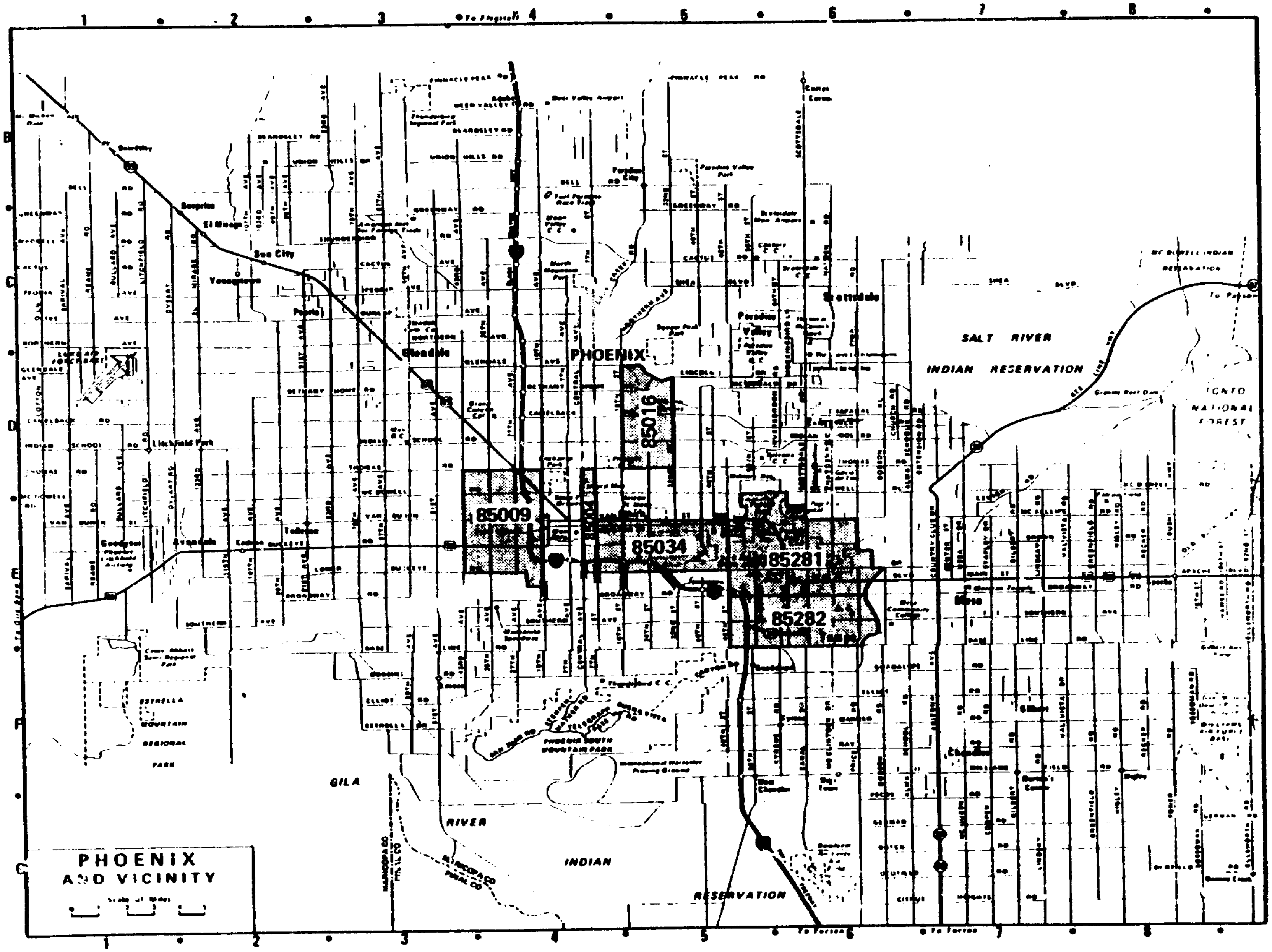


FIGURE IV-10

utilities and government agencies, operate primarily on a statewide basis.

- Phoenix is a young city without well established ties.

- Arizona, because of its location, is geographically distant from other major population areas of the U.S.A.

Interstate voice traffic is conducted using WATS lines because of the random nature of phone calls. Many of the respondents were part of a nationwide corporate operation, with branch offices scattered throughout the country. Few single locations had sufficient voice traffic to justify a dedicated trunk between it and Phoenix. Only Tucson had substantial voice traffic to require a large number of dedicated trunk lines connecting it to Phoenix, primarily because of the intrastate traffic of the government agencies, utilities, and banks with offices located in both Phoenix and Tucson.

Videoconferencing generated a high level of interest among survey respondents. Business meetings and training were identified as the major applications of videoconferencing. There was a significant increase in usage projected between 1980 and 1990 according to the survey. Alternatives to videoconferencing, such as a combination of audioconferencing and high speed facsimile, may possibly decrease market demand for the service. Survey results revealed that 40% of videoconferencing applications could be replaced by a combination of audioconferencing and high speed facsimile. The Stanford Research Institute published comparable estimates; 41% of all business trips could be substituted for by audiographic facilities.

Several factors may limit videoconferencing demand, such as technical problems, cost, and psychological barriers. Most respondents cited cost as the major factor, but a number of applications are limited by technical and psychological constraints. The feeling of actual "presence" is dependent on new technical innovations, and many business meetings require close physical and emotional contact among the participants. However, the increasing worldwide fuel shortage may force the acceptance of videoconferencing as an alternative to travel.

A significant proportion of companies with current plans to install dedicated or shared earth stations were television and radio stations and newspapers. These companies have major video and audio traffic requirements and earth stations are viable alternatives to other transmission media. Potential earth station installations may be located at industrial parks in Phoenix where the collective traffic requirements of several companies justify the facility. The growth of wideband applications will increase the demand for earth stations during the 1980's. Currently, only a few companies (e.g., CATV Companies) require an earth station facility.

Fiber optics generated little interest among survey respondents. The awareness level of fiber optic technology and its applications was very low because few applications for users currently exist. Until new and less expensive applications emerge from fiber optics, users will continue to show limited interest.

Respondents who have conducted feasibility studies of electronic mail services did not believe that a significant percentage of present mail volume could be handled electronically. A recent study published by a British consulting firm reported similar findings. Several categories of mail generated by the respondents are not conducive to electronic handling: advertising brochures; bill payments; mail to the public; and mail to locations without adequate facilities for handling it electronically.

High-speed facimile applications within the next five years will almost triple present usage requirements. This can be attributed to declining equipment costs and greater acceptance by the user community. Better quality resolution, faster transmission, and more applications contribute to the latter factor.

Communicating word processors are often purchased for future communications applications, and initially are used primarily for word processing. The very low percentage of communicating word processors actually communicating indicated that there is an untapped potential source for telecommunications services.

Average annual growth of telecommunications expenditures, according to survey respondents, will continue its past five year trend during the next five years. Large increases are expected for data, and, to a smaller extent, video. The trend to distributed processing will add to the growth, leading to increased equipment expenditures for the short term. Utilities are expected to experience the smallest growth rate, under 5% annually. Retailers, according to the survey, are expected to show very large increases, primarily because of their current low expenditure base. Survey findings are consistent with other published projections.

Survey results show a trend toward increased high speed transmission (9600 bps and higher). Lower speed (2400 bps and lower) transmission is expected to decrease, while medium speed transmission (4800 bps) appears to be levelling off. The time frame includes the years 1978 through 1990. High speed transmission will increase due to decreasing computer and terminal equipment costs and the trend to distributed processing networks. In the future there will be more applications for computers, as well as more computers in use within business sectors previously not considered major users. Networks will start-up with mini- or micro-computers and expand towards the installation of larger, mainframe networks.

7.B IMPACT ON OTHER STUDY AREAS

Unlike the other study areas, Task 4 is confined to a single metropolitan area. There are metropolitan areas across the country different from Phoenix in terms of size, demographics, and growth stage.

Telecommunications traffic destinations are dependent on too many variables to use Phoenix or any other city as being totally representative for all metropolitan areas. General equipment applications and service requirements, however, can be applied to the other studies because the sample frame was a valid cross section of the total market. Judgement must be used in applying the actual figures derived from analysis.

Several findings were significant and can be applied to other studies: the trend to higher operating transmission speeds; increased telecommunications expenditures within the next five years; the expected use of videoconferencing; the installation of dedicated or shared earth stations; and electronic mail service acceptance.

Some information peculiar to Phoenix, such as select areas of significant local telecommunications traffic volume, can be analyzed and applied to other cities: number of "pockets of communication"; traffic volume per area; distance between origins and destinations of traffic; and distribution of traffic by service (voice, data, video).

7.C PHOENIX TELECOMMUNICATIONS MARKET SCENARIO IN THE YEAR 2000

A market scenario for the year 2000 is included because of the hesitancy of survey respondents to project telecommunications requirements beyond the year 1990. To satisfy the objectives of the study, data sources were used to construct a probable telecommunications market scenario of Phoenix and its surrounding community in the year 2000. The scenario is based on the collective comments and opinions of all survey respondents and published forecasts of telecommunications services.

7.C.1 Distribution of Service Expenditures

Based upon current trends, by the year 2000 the distribution of telecommunications expenditures will be approximately 60% voice, 30% data, and 10% video. Data services, as a percentage of total expenditures, should peak by the mid-1990's and level off through the year 2000. The growth in video service expenditures will be due in part to the increased use of videoconferencing applications. Voice service will still demand the greatest proportion of expenditures. New areas, such as Deer Valley, Fort McDowell, and Sun City, should by the year 2000 be included in the Phoenix Metropolitan Telephone Exchange Boundary. Satellite transmission services should reduce the cost of long haul telecommunications traffic, but increase the traffic volume.

7.C.2 Local Phoenix Traffic

Local Phoenix voice and data traffic requirements will continue to increase throughout the 1990-2000 time frame. Data traffic volume will grow at a faster rate than voice traffic. Downtown Phoenix, because of centralized banking, service companies and government operations, will remain the center of telecommunications activity, but expansion to the areas surrounding central Maricopa County will create new "pockets of communication" much like the current situation in Mesa and Tempe. Mountain Bell sources indicate that voice traffic in the heart of Metro Phoenix is leveling off while outlying areas such as Chandler and Deer Valley are rapidly growing in terms of telephone exchange requirements. As industrial space becomes scarce in current locations, areas such as Chandler, Fort McDowell and Litchfield will attract new industry and experience greater data traffic requirements. Distributed processing systems will create localized concentrations of data volume scattered throughout the entire Phoenix area while a select number of areas will continue as centers of data traffic for several users.

7.C.3 Transmission Media

Earth station installations and fiber optics applications should be widely used by the year 2000. Current projections of earth station shipments indicate that the Phoenix Metropolitan area will have approximately thirty-five to fifty earth stations in operation. Probable users of the facility are broadcast media companies, Fortune 500 companies, utilities, federal and state governments, large banking institutions, large educational institutions, and service companies requiring earth stations for transmission of significant telecommunications traffic volume. The exact number of dedicated earth stations will be dependent upon equipment cost, traffic volume, and the number of applications. Proposed telecommunications networks will also affect earth station shipments. Shared facilities may be located at industrial park developments, or one regional earth station installation may handle the area's needs.

Fiber optic cable shipments are expected to grow at a very small rate through the 1980's. By the year 2000, local loop requirements could spur the demand for fiber optics to complement the growth of earth station operations. Applications of fiber optics will include intracompany telecommunications networks and transmission media relays between node concentrations. Principal users of fiber optics will be large hospitals, educational institutions, state government offices, banks, and large manufacturers.

7.D VIDEOCONFERENCING

Videoconferencing applications may not be as numerous as projected by survey respondents. A large percentage of videoconferencing applications can be satisfied using a combination of other services. Several factors adversely effecting videoconferencing applications, such as costs, volume requirements, and user resistance, may be negated by travel restrictions that might be imposed by the energy shortage. Almost all companies using satellite transmission will be potential videoconferencing users.

SECTION 5

TASK 5 PRESENT AND PROJECTED TERRESTRIAL AND C AND Ku-BAND SATELLITE SERVICE COSTS

INTRODUCTION

This task is designed to establish the cost relationships between terrestrial and C and Ku-band satellite transmission. These relationships allow a determination of competitive choice based on transmission distance between distance sensitive terrestrial service and distance insensitive satellite service. A cost estimate for terrestrial tails needed to link subscribers to 18/30 GHz earth terminals also is required. The task concludes by applying these cost relationships, together with a number of usage and technical characteristics, to quantify the portion of long haul traffic suitable for satellite transmission systems.

METHODOLOGY

Task 5 is divided into three subtasks:

- Subtask 5.A Service Cost Comparisons
- Subtask 5.B Terrestrial Tails Cost
- Subtask 5.C C and Ku-Band Service Volume

Subtask 5.A provides an economic evaluation of various terrestrial and satellite long haul transmission systems through the construction of a parametric cost model. Current costs are calculated and cost trends identified to the end of the century based on historical data and anticipated developments in technology. Satellite costs are generated for four system configurations: TDMA and FDM for both C and Ku-band frequencies. One voice and three representative types of data/wideband communications trunking system costs are evaluated. Information derived from subtask 5.A is combined with the output of subtask 5.B to form the terrestrial/satellite cost crossover distances, used as one of the principal criteria in the separation of terrestrial and satellite traffic (subtask 5.C) and the quantification of market demands for C and Ku-band (subtask 5.C) and 18/30 GHz (subtask 6.C) systems.

Subtask 5.B provides an economic evaluation of four methods of connecting satellite channels to the users' premises through the use of terrestrial links. The methods considered are direct microwave link, coaxial cable, fiber optic cable and the analog telephone system. Current and projected costs are calculated and forecast for the years 1980, 1990 and 2000. Information from subtask 5.B is combined with the satellite trunking costs generated in subtask 5.A to establish end-to-end satellite channel costs.

Subtask 5.C segregates and quantifies the C and Ku-band net addressable satellite market demand. This is accomplished by subjecting the net long haul traffic forecasts established as a part of subtask 2.A to a number of usage and technical qualifying criteria (established as a part of this subtask) and to the terrestrial/satellite cost separation distance crossovers generated in subtasks 5.A and 5.B. The resultant forecasts first quantify that traffic suitable to satellite implementation (C-band addressable satellite market), then segregate that traffic which is also suitable to the higher frequency, Ku-band systems.

TASK 5.A SATELLITE SERVICE COST ANALYSIS

1.0 STATEMENT OF WORK

The contractor shall determine and list the present and projected (years 1980, 1990 and 2000) service costs of terrestrially delivered and C and Ku band satellite delivered communications services as a function of distance. The contractor shall document the assumptions used in determining the projected service costs.

2.0 INTRODUCTION

2.A PURPOSE

Three reasons are postulated for estimating alternate transmission service costs:

- Service cost is a key factor in determining user service selection. The evaluation of satellite service costs can assist in the segregation of traffic demand between satellite and terrestrial means.
- The economic advantages of satellite transmission are expected to improve over time, due essentially to more efficient satellite systems. The cost model examines projected changes in the service costs over the 1980-2000 period to determine whether the economic analyses will favor satellite systems.
- Comparisons of alternate satellite systems (TDMA, FDM) and two frequencies (C and Ku band) will indicate the optimum system configuration for delivery of individual services. The economics of providing end-to-end satellite service can thus be compared under a variety of system configurations.

2.B SCOPE

The parametric satellite facility cost model considers a broad number of system alternatives. These include three time periods, two transmission frequencies, eight earth station types and four communication services. Since many variables are possible, it is important to specify the major parameters that have been used.

The cost model considered the change in satellite and terrestrial costs over three time periods: 1980, 1990 and 2000, all in 1978 dollars. Space segment transmission, in the 6/4 and 14/12 GHz bands, has also been considered. The model initially evaluated eight different earth station types shown in Table V-1. Later refinements reduced the number of earth station types to four variations.

In addition, the model considered four services: voice, low speed data (0-1200 bps), medium speed data (2400-9600 bps) and high speed data (56 Kbps and higher). It was not feasible to use the model to ascertain the video service costs. Video service costs, because of their broadcast nature, depend heavily on the number of downlinks and terrestrial routing alternatives. Generally, satellite delivery of video broadcast has maintained a lower cost alternative to terrestrial systems.

Table V-1 - Earth Station System Alternative

C Band	-	Trunking
		. TDMA
		. FDM
Ku Band	-	Trunking
		. TDMA
		. FDM
C Band	-	Direct to User*
		. SCPC
		. TDMA
Ku Band	-	Direct to User*
		. SCPC
		. TDMA

*Not included in cost study

2.C APPROACH

A Parametric Satellite Facilities Cost Model was developed to reflect current and future C and Ku band satellite service costs. The model has a representative earth station network with assigned capacity and further divided among the primary services. It is a computer-based model which has utilized cost assumptions and projections developed by Future Systems Inc. (FSI). These assumptions and conclusions are disclosed in the FSI report entitled "Satellite Transmission Considerations, In Support of 18/30 GHz Service Demand Study", dated October 1978.

The model has taken into account a number of expected advances in satellite and earth station technology as well as the affects that these new developments will likely have on system costs.

System costs, expressed in 1978 dollars, were projected for the time periods of 1980, 1990, and 2000. For each of these time periods the model generated an annual cost-to-serve projection via C and Ku band satellite systems by service category. The service categories included:

- 4 KHz Voice Channel
- Data Channel
  - Low Speed 0-1200 bps
  - Medium Speed 2400-9600 bps
  - High Speed 56000 bps

System performance characteristics and earth station requirements were also based on the FSI Report. Earth station costs are treated as a function of critical components such as antennas, transmitters and receivers. Production quantity considerations are reflected in the cost model because of the FSI assumption of a multi-station network.

For terrestrial service, a detailed analysis of existing common carrier tariffs yielded representative service rates as a function of distance. The representative tariffs used for comparison purposes were:

- Series 2000 Private Line - Voice
- Series 1000 Private Line - Low Speed Data
- Series 3000 Private Line - Medium Speed Data
- 56 Kbps Dataphone Digital Service - Wideband Data

A projection of terrestrial tariff rates was made for all communication services based on historical changes in tariff rates versus the Consumer Price Index (CPI) over time. The terrestrial rates, expressed as a function of the distance for each channel, were compared with the annual cost of a single end-to-end satellite channel. This comparison determined the break even or crossover point for satellite service delivery.

3.0 METHODOLOGY

3.A PARAMETRIC SATELLITE COST MODEL

3.A.1 Model Construction

The cost assumptions for the Parametric Satellite Facilities Cost Model were based primarily on the report entitled "Satellite Transmission Considerations, in Support of 18/30 GHz Service Demand Study" - a report prepared for Western Union by Future Systems Incorporated (FSI) - dated October 1978.

The parametric cost model consisted of a representative ten (10) earth station configuration for a trunking network. TDMA and FDM multiplexing modes for C band and Ku band frequencies were considered for each of four service categories (voice, 300 baud data - Low speed, 9.6 Kbps data - Medium speed, and 56 Kbps data - High speed). This resulted in a total of sixteen different costs to serve for each time period (1980, 1990, and 2000).

The model incorporated varying network traffic mixes for each time period for each of the four service categories, as shown in Table V-2.

Table V-2 - Service Traffic Mix

SERVICE CATEGORY			1980	1990	2000
Voice			80%	65%	50%
Data:	300 baud		13	14	15
	9.6 Kbps		6	18	30
	56 Kbps		1	3	5
		TOTAL	100%	100%	100%

The space segment costs (integral number of transponders) are also allocated to each service category on the basis of equivalent number of voice channels. The integral number of transponders is the product of rounding up to the next highest value of transponders required to meet traffic loads. The per channel space segment costs are based on 1000 one-way voice channels per transponder.

The transmission approaches the model considers for each of the service categories are as follows:

Service Category	Approach
a. Voice	The FDM transmission mode uses analog voice channel. The TDMA transmission mode uses analog voice channel with digital Pulse Code Modulation transmission without Digital Speech Interpolation.

Service Category	Approach
b. 300 Baud Data	Employs 9.6 Kbps data channels, with TDM multiplexing to derive low speed data service. The load per channel is assumed to be 1/2 of capacity, (namely ten 300 baud duplex channels).
c. 9.6 Kbps Data	Uses analog voice channels with 9.6 Kbps modems added (Note: since the number of 9.6 Kbps channels per route is small, the use of 9.6 Kbps modems on voice channels was selected instead of multiplexing (TDM) the 9.6 Kbps channels on a 56 Kbps TDMA channel.)
d. 56 Kbps Data	The Frequency Division Multiplex approach uses a channel group (12 equivalent voice channels) with 56 Kbps modems. It includes a portion of high order multiplex and requires 12 times the voice channel bandwidth. The TDMA transmission mode uses a digital interface unit (in lieu of a PCM unit) for a voice channel, and it requires the same bandwidth as a single voice channel in a TDMA mode.

The basic model cost algorithm per earth station type is based on the following formula:

$$A = \frac{F + m\,(B + E) + n\,(C + S)}{n}$$

where

A = earth station system investment cost per channel

F = capital cost factors common to the entire system

m = number of earth stations in the system

B = capital cost elements common to all channels at each earth station

E = entrance link capital costs

n = number of channel units in the system that are all of the same type

C = capital cost factors that vary with the number of channels

S = space segment cost per channel.

It should be noted that the above cost algorithm is valid for the initial step only, because the space segment is calculated and rounded up to full transponder and then reallocated to individual services.

The above costing elements are converted to annual recurring costs by application of a .28 annualization factor. This factor is derived as follows:

- Operations and maintenance is assumed to total 8% of initial investment. .08
- Earth station equipment will have an average useful life of 10 years. Assuming an average rate of return of 10% on original investment, this equates to about a 20% return on net investment after deducting depreciation. .20

Total Annual Recurring Cost .28

The per channel costs are based on fully equipped earth stations and entrance links, with a traffic load of 70% of system capacity of 480 equivalent voice channels per earth station.

The manufacture of greater quantities, the further development of lower cost, more reliable components, and the effects of supply and demand will result in cost reductions to the model cost elements, as shown in Table V-3.

Table V-3 - Projected Cost Reduction Elements

COST ELEMENT		COST REDUCTION FACTOR		
		1980	1990	2000
Common Ground Equipment	(F)	.89	.66	.53
Investment per Earth Station	(B)	.89	.66	.53
Entrance Link	(E)	1	1	1
Channel Equipment	(C)	[illegible]	.66	.53
Space Segment	(S)	1	1	1

3.A.2 System Characteristics

For future space segment systems a number of new technologies are expected to impact commercial satellite communications. Rapid technological advances which have occurred since 1965 are foreseen for the future.

It is expected that the space shuttle will be used to launch geostationary satellites in the 1980's. The Shuttle cost factor identified by NASA, plus NASA estimates of an average fill factor of 75% were the assumptions utilized.

Additional technological developments expected to be incorporated in future satellite systems include:

- Higher Frequency Bands
- Higher Capacity Per Satellite
- Multiple Spot Beams Per Satellite
- On-Board Switching and Processing
- Digital Coding and Processing
- Greater On-Board Power Generation

The representative space segment was based on a satellite system model consisting of the following parameters (Table V-4).

Table V-4 - Satellite System Model Characteristics

	C BAND SATELLITE	Ku BAND SATELLITE
Number of In-Orbit Satellites		
- Operational	2	2
- Spare	1	1
Equivalent Number 36 MHz Transponders	24	12
In-Orbit Weight (Kilograms)	550	550
Primary Power (Watts)	500	500
VF Channels Per 36 MHz Transponder	1000	1000
Depreciable Life (Years)		
- Spacecraft	7	7
- Development Costs	10	10

The satellite model has been kept simplified in order to reduce the number of variables to be considered. A more detailed model is required where greater accuracy of service costing is required.

Ground segment systems contain a great variability in operating characteristics for a given earth station type and depend on many interrelated factors.

Perhaps the most important single variable system parameter in earth terminal costing is economy of scale. This relates in particular to the earth station network size. A large number of earth stations per satellite channel results in a higher system utilization and lower annual cost per user.

Subsystem elements considered in the earth station varied in cost and size as well as transmission capacity. Initially a careful examination was made by Western Union's subcontractor of the array of subsystems and associated costs, in 1978 dollars. All equipment was assumed to be provided on a redundant basis to maintain system reliability. From this array of alternatives an optimized selection of combined equipment was made for four different earth station types.

There were four combinations of trunking earth station types analyzed in the cost model. Because of the potentially great variability and configuration of direct-to-user earth stations, this approach was omitted from further analysis. The combinations represent the two frequency bands (C Band and Ku Band) and two multiplexing modes (TDMA and FDM/FDMA). The resulting configurations of earth stations systems are shown in Table V-5.

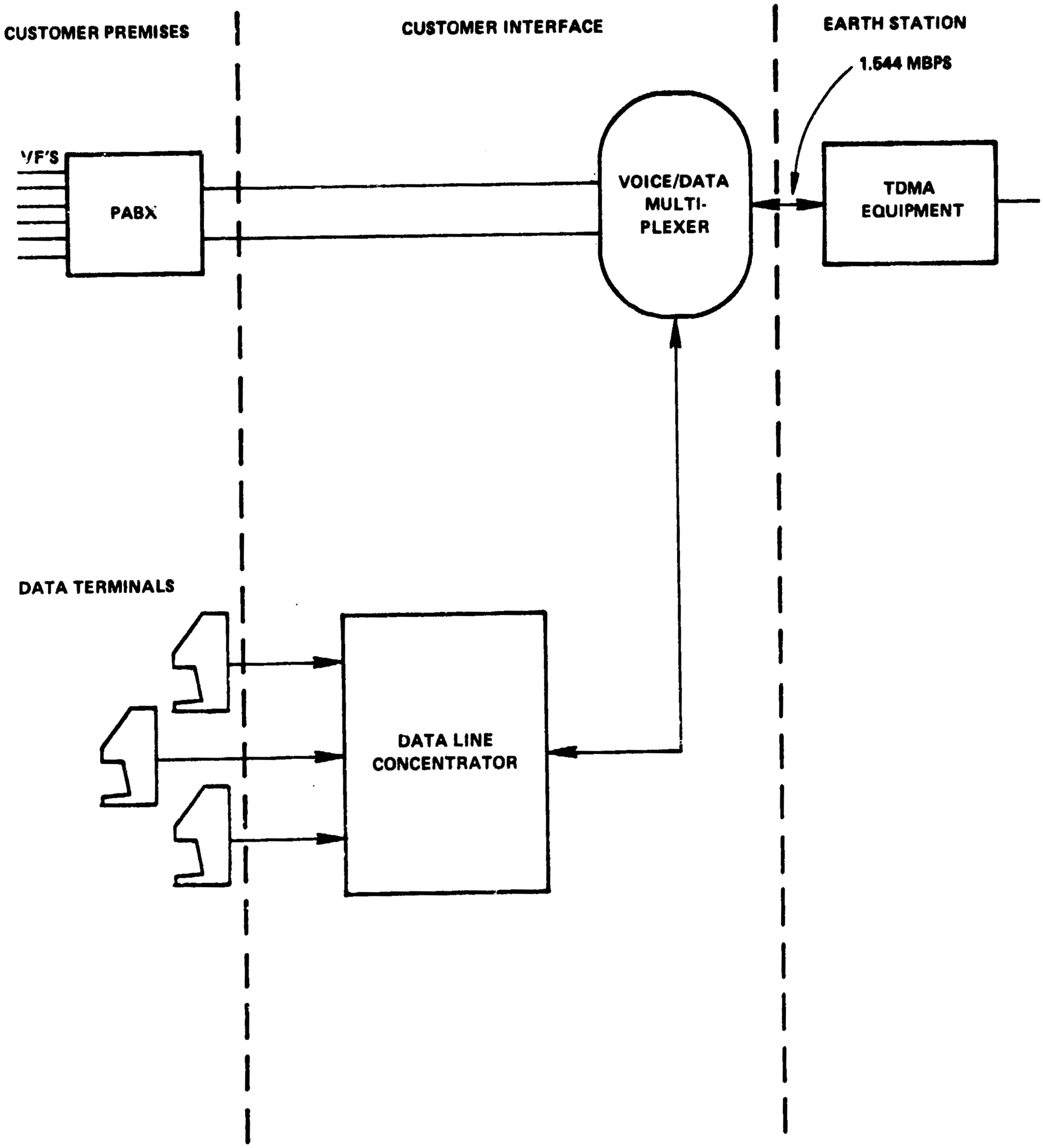
Table V-5 - Earth Station Systems

C-Band Trunking	Ku-Band Trunking
. TDMA	. TDMA
. FM/FDM	. FM/FDM

Additional system elements included in the model were entrance links to the earth stations, switching center equipment and customer interface equipment.

The microwave entrance links represent the terrestrial repeater/ terminals to interconnect the earth station with the city switching center. Included in this system element is the land, towers, buildings, transmitter, baseband multiplex equipment and RF equipment capable of handling 480 voice channels.

Figure V-1 shows a typical customer interface block diagram. The interface between the voice/data multiplexer in the customer interface and the earth station is at the T-1 (1.544 Mbps) level.



CUSTOMER INTERFACE EQUIPMENT

FIGURE V-1

The data concentrator equipment consists of data input and output ports capable of speeds up to 9600 bps plus other common equipment.

The voice/data multiplexer accepts any combination of 56 Kbps data lines and voice channel inputs. The output is a T-1 stream. Individual voice or data cards can be added as required to permit modular growth to accommodate additional traffic.

3.A.3 Cost Assumptions

The basic cost assumptions used in the Parametric Facilities Cost Model rely heavily on information supplied in the Future Systems Inc. report rather than cost data generated internally by Western Union.

3.A.3.a Space Segment Costs

The space segment cost assumptions, as developed by FSI, are based on a revenue requirements model for determination of annual C and Ku band transponder costs. The basic space segment assumptions are:

- Seven year satellite life cycle.
- Revenue requirements provides for a 10% rate of return, depreciation and annual operation and maintenance.
- All costs are in constant 1978 dollars.
- Recurring spacecraft and launch costs are increased by a cost factor of 1.11 to allow for potential launch failures.
- Costs were increased by 20% based on the statistical expectation that an average 20% of all satellites fail prior to the expected 7 year life and have to be replaced.
- Provision for investment in TT&C and satellite control facilities added another 5% to the total spacecraft and launch investment.
- The space segment investment includes three satellites and three launches, with one satellite serving as an in-orbit spare.

- The traffic model, developed by FSI, assumes a linear growth in transponder demand over the 7 year life from an initial demand of 24 and 3 transponders for the C and Ku band systems respectively, to a maximum demand equivalent to the capacity of the two satellites, 48 for C band and 24 transponders for Ku band.

Based on the foregoing cost assumptions and traffic model, a year-by-year calculation of the cost per C and Ku band transponder was completed. This is displayed in Table V-6.

Decline in future years' cost per transponder are mainly due to more efficient satellite loading, and also because the net investment is lower due to accumulated depreciation charges.

Table V-6 - FSI Model Transponder Costs
(Millions of 1978 Dollars Per Year)

Year	TRANSPONDER TYPE C Band	Ku Band
1	1.17	5.51
2	1.31	4.22
3	1.12	2.70
4	.97	2.69
5	.81	2.04
6	.69	1.60
7	.59	1.29
Weighted Average Annual Cost	$0.80	$1.90

In the FSI cost model, Ku band transponder costs are higher, about twice the cost of the C band transponders. There are several reasons postulated for this occurence in the parametric model.

First, during the early years of operation, the traffic fill factors for Ku band satellites are lower than the fill factors for the more mature C band system.

Second, the cost model assumed the C band satellite has a capacity for 24 transponders while the Ku band satellite has a capacity for only 12 transponders.

3.A.3.b Ground Segment Costs

The individual earth station configurations have been outlined in the System Description. Each earth station consists of the following major subsystems:

- Antenna
- Low Noise Amplifiers
- High Power Amplifiers
- Frequency Converters
- Baseband Equipment
- FDM/FM Equipment (where applicable)

Typical trunking earth stations are either of two types: TDMA or FDM. The trunking station size is further divided into low, average and high capacity categories. Tables V-7 to V-10 show investment costs for typical earth station sizes. The cost component "station integration" includes the costs of transportation and installation, documentation, space and training. It has been estimated to be 40% of the typical earth station cost.

All costs displayed in Tables V-7 to V-10 are for earth stations in constant 1978 dollars. In the absence of inflation, earth station costs have been assumed to decrease by about 50% by the year 2000. This corresponds to an average decrease of 2.9% per year. The costs of earth stations for use with C and Ku band satellite systems over the 1980 to 2000 time period are shown in Figure V-2. These cost curves are for all types and sizes of earth stations.

The major reasons for the projected cost declines in earth stations are:

- Greater production quantities
- More efficient manufacturing operations
- Increasingly reliable station components
- Greater number of satellite communication systems

3.A.3.c Entrance Link Costs

Terrestrial entrance links to the central office for C-band trunking stations are required because these stations must be sited at more remote locations than Ku band stations. Ku band trunking stations are easier to coordinate and can be placed closer to the central office locations.

The entrance links to the trunking stations consist of terrestrial microwave radio and include terminals, repeaters, RF equipment, modulator/demodulator, and baseband multiplex equipment at both ends. It is assumed that the average interconnection lengths for C band and Ku band are 2.5 and 0.5 hops, respectively.

Table V-7

Typical C-Band FDM/FM Trunking Earth Station Costs

In Thousands of 1978 Dollars*

	Capacity Low 120 Channels	Average 240 Channels	High 480 Channels
13-meter Antenna	132	132	132
HPA, 200 W	60	60	60
LNA, 120°K	30	30	30
Frequency Converters	48	56	80
FM Equipment	182	310	580
Station Integration	180	235	353
Total	632	823	1,235

Table V-8

Typical Ku-Band FDM/FM Trunking Earth Station Costs

In Thousands of 1978 Dollars*

	Capacity Low 120 Channels	Average 240 Channels	High 480 Channels
13-meter Antenna	200	200	200
HPA, 1 kw	100	100	100
LNA, 150°K	50	50	50
Frequency Converters	60	70	100
FM Equipment	182	310	580
Station Integration	237	292	412
Total	829	1,022	1,442

*The earth station configurations used were:

Low capacity	1 up chain, 3 down chains
Average capacity	1 up chain, 4 down chains
High capacity	2 up chains, 6 down chains

with one redundant chain in each direction

Table V-9

Typical C-Band TDMA Trunking Earth Station Costs

In Thousands of 1978 Dollars

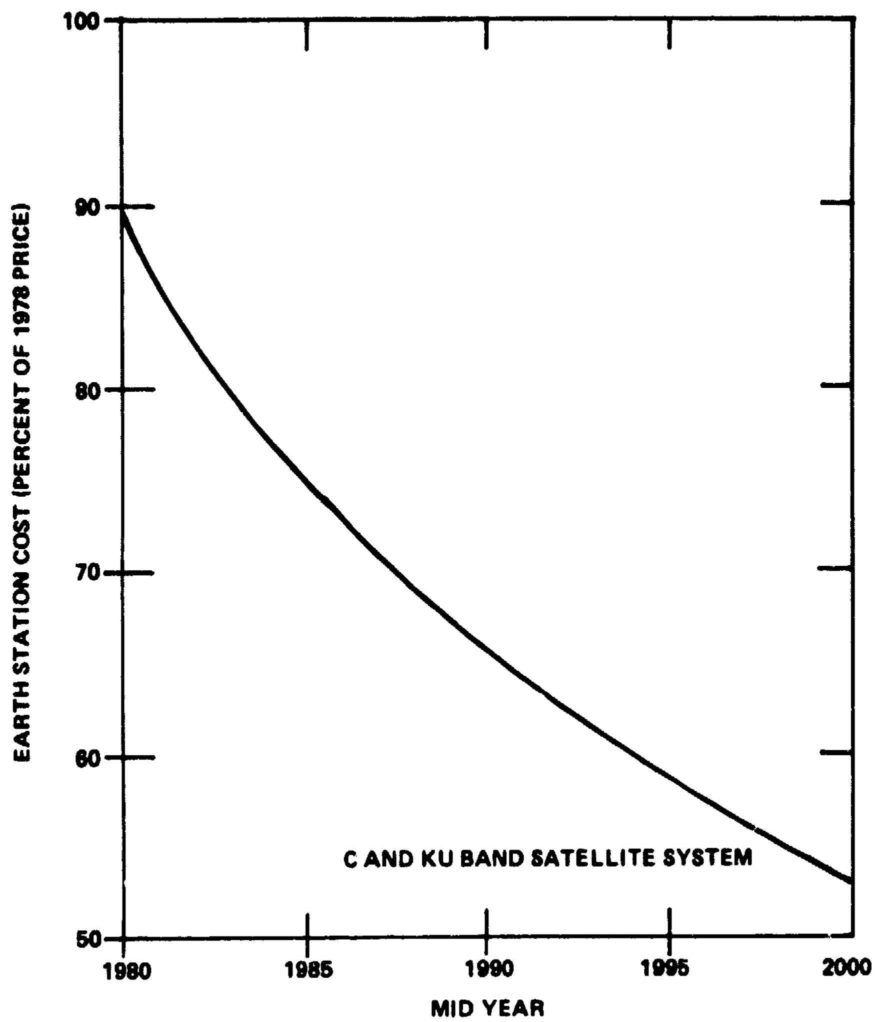
	Low 120 Channels	Capacity Average 240 Channels	High 480 Channels
13-meter Antenna	132	132	132
HPA, 200 W	60	60	60
LNA 120°K	30	30	30
Frequency Converters	38	38	38
TDMA Common Equipment	400	400	400
Voice Channel Equipment (No DSI)	36	72	144
Station Integration	278	293	322
Total	974	1,025	1,126

Table V-10

Typical Ku-Band TDMA Trunking Earth Station Costs

In Thousands of 1978 Dollars

	Low 120 Channels	Capacity Average 240 Channels	High 480 Channels
13-meter Antenna	200	200	200
HPA, 1 kW	100	100	100
LNA 150°K	50	50	50
Frequency Converters	50	50	50
TDMA Common Equipment	400	400	400
Voice Channel Equipment (No DSI)	36	72	144
Station Integration	334	349	378
Total	1,170	1,221	1,322



RELATIVE EARTH STATION COSTS
VERSUS TIME (1980 - 2000)

FIGURE V-2

3.B TERRESTRIAL SERVICE COSTS

3.B.1 Current Rates

Due to the complexity and numerous possible combinations of terrestrial transmission systems, the most representative source of terrestrial costs are current private line tariff rates. Accordingly, the common carrier tariff rates for each of the four voice and data services have been utilized, effective year-end 1978, as representative current terrestrial service costs.

While the Specialized Common Carriers' private line service rates tend to be less costly than those offered by AT&T, Bell provides private line services to an estimated 75% of the market. Therefore, AT&T Tariffs 260 and 267 have been used for the purpose of comparing analog and digital transmission service rates.

Each tariff rate contains at least two monthly charges: an IXC or interexchange rate per mile and a station and/or terminal charge per end. Costs for modems or terminal equipment have been assumed to be customer-provided. Table V-11 summarizes the specific tariff used for each of the four service categories as representative of terrestrial costs.

Table V-11 - Comparative Service Tariffs

SERVICE	FACILITY	TARIFF TYPE
Voice	300-3000 Hz Private Line	Type 2001
Low Speed Data	0-150 Baud	Type 1006
Medium Speed Data	Conditioned 4 Khz Private Line	Type 3001
Wideband Data		
- Analog	Conditioned 48 KHz Line	Type 8800A
- Digital	56 Kbps Private Line	DDS

A conversion has been made of the monthly interexchange charges and flat rate station terminal charges to produce the base year's annual terrestrial rate as a function of distance.

3.B.2 Historical Terrestrial Rate Changes

One interesting phenomenon in these inflationary times is the relative cost of communications services. Historical data reveals an interesting fact that expenditures on telephone and telegraph services have either remained constant or declined on a constant dollar basis.

Economic analysis reveals that prices of telephone and telegraph services have increased much less rapidly than all consumer spending on a per unit basis over the last eight years. Several reasons seem to account for this.

First, since 1970 competitive pressures from the introduction of specialized common carrier services have held down requests for rate increases, especially on high traffic routes. Second, this same high traffic volume (growing at some 10-12% per year in interstate toll call) has permitted spreading costs over a larger traffic base. Third, the FCC by continually reviewing the telephone companies rate base and rate of return, has made these companies more cautious about filing rate increase requests. And lastly, the introduction of more efficient switches and trunks gradually over this period has helped to reduce operations and maintenance costs for telephone companies.

Interstate revenues for total service has risen significantly between 1970 and 1978 but most of this increase is due to greater usage rather than changes in unit prices. For example, a three minute direct call between New York and Los Angeles during business hours had cost $1.45 in 1973 and today costs the user $1.30, representing a 10% decline in price.

An analysis made by the U.S. Department of Commerce in 1977 concerned itself with personal consumption expenditures. After analyzing all personal consumption expenditures between 1965 and 1975 the study found in constant dollar terms (1965 = 100) expenditures on telephone services had actually declined during that decade. This decline in constant dollars was due not to a decline in telephone call volumes but to the relatively small increases in unit service prices. This indicated that prices of telephone services have risen more slowly than the cost of inflation during the 1965-1975 period. And this trend is expected to continue in the future.

3.B.3 Projected Terrestrial Rate Changes

Over the past 25 years the U.S. has experienced an average inflation rate of 3.7%, compounded over time. However, in the past five years that average rate has risen to approximately 7.4%. Given a more stable economy during the next 22 years (1978-2000), the average inflation rate is projected to be around 5.7%.

As mentioned previously, all costs in the Parametric Model are stated in fixed 1978 dollars. Given the historical trend data concerning interstate toll rates and the anticipated inflation rate level, the average annual projected decline in terrestrial communications rates is expected to be about 1% per year. This factor has been included in the terrestrial rate portion of the cost model for service cost comparison purposes.

4.0 PRESENTATION OF RESULTS

4.A INTRODUCTION

For C band and Ku band satellite services a number of per channel cost configurations are developed. Presented below are the annual end-to-end channel costs for each of the four communication services, projected over three time periods, and for each earth station system alternative. In addition, two cost analysis cases are shown which display:

- The break even point where satellite and terrestrial costs are equal.
- The crossover point with satellite cost 20% higher than at the break even point.

The second alternative is developed to reflect market considerations where satellite rates are 20% below terrestrial service to influence a significant traffic volume movement to satellite.

4.B C-BAND SATELLITE SERVICE COSTS

Table V-14 shows the annual per channel costs for a C-band trunking FDM earth station model. C-band satellite systems are most cost effective using FDM because of the capability for efficiently carrying voice traffic in an analog mode without the use of digitizing equipment. The Table indicates that while all service rates are projected to decline, the most rapid reduction in C-band satellite service is projected for low speed data channels. This is due to the potential for increased satellite fill for these types of circuits with little associated incremental cost.

Table V-14 - C Band Satellite Service Costs

Trunking FDM Network

BASE CASE	ANNUAL COST PER CHANNEL		
SERVICE TYPE	1980	1990	2000
Voice	$ 5669	$ 5014	$ 4629
300 Baud Data	2123	1792	1603
9.6 Kbps Data	9451	8008	7194
56 Kbps Data	81690	70553	65770
+ 20% CASE			
SERVICE TYPE			
Voice	6839	6017	5555
300 Baud Data	2548	2150	1924
9.6 Kbps Data	11341	9610	8633
56 Kbps Data	98028	84664	78924

4.C Ku-BAND SATELLITE SERVICE COSTS

Delivery of satellite services in the Ku-band frequency is under development by both Western Union and Satellite Business Systems. It has been found that Time Division Multiplex, Multiple Access (TDMA) is the most efficient modulation approach in the 12/14 GHz band. The cost model displays in Table V-15 the annual service cost for a Ku-band, TDMA trunking network on an annual service channel basis.

The Ku-band service costs are not expected to decline on a percentage basis as rapidly as C-band services. Figure V-3 provides the explanation for this occurrence. In both the C and Ku-band satellite models, space segment costs are assumed to remain constant. For most services, the Ku-band space segment represents almost twice the proportion of total C-band service cost. As seen in the figure, the space segment for a Ku-band channel is about 55% of the total annual cost versus 31% in the case of C-band channel costs. Therefore, other cost elements, which are anticipated to decline over time, are smaller in proportion to total cost for Ku versus C-band, and hence the lower rate of decline over time.

Table V-15 - Ku Band Satellite Service Costs

Trunking TDMA Network

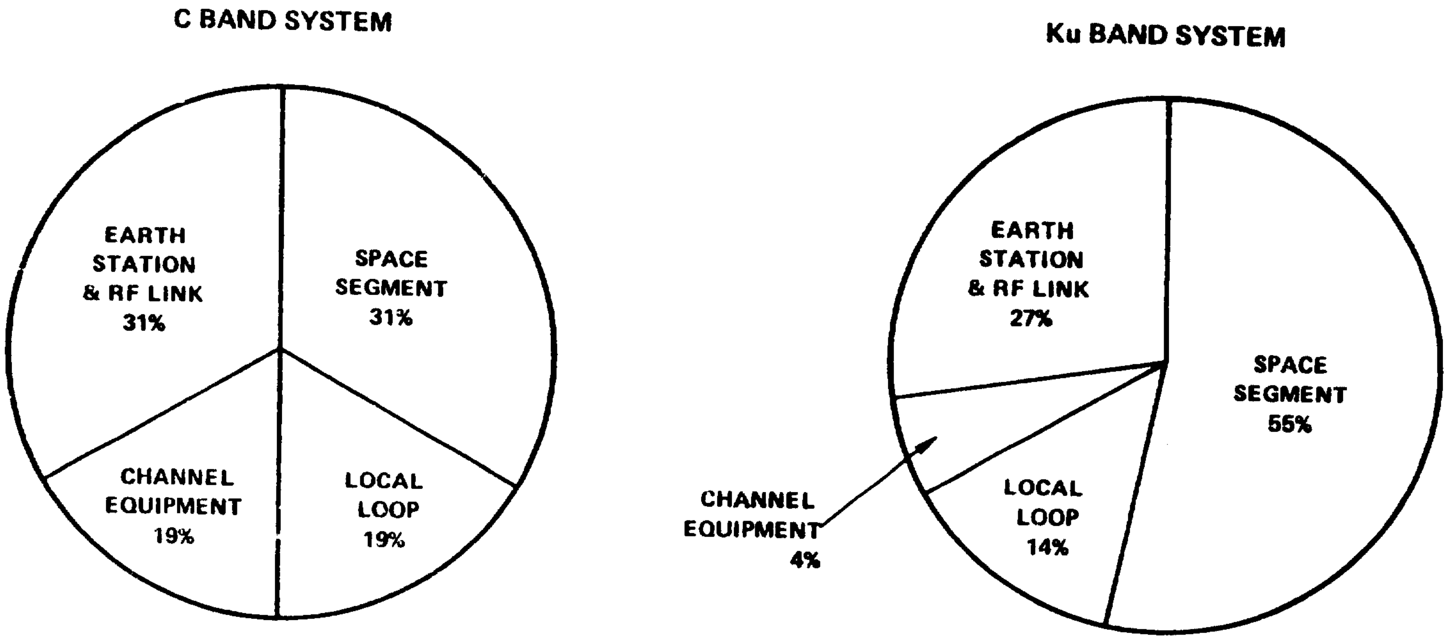
BASE CASE	ANNUAL COST PER CHANNEL		
SERVICE TYPE	1980	1990	2000
Voice	$ 8177	$ 7667	$ 7345
300 Baud Data	2369	2054	1871
9.6 Kbps Data	17499	16213	15463
56 Kbps Data	30430	29582	29175
+ 20% CASE			
SERVICE TYPE			
Voice	$ 9812	$ 9200	$ 8814
300 Baud Data	2843	2465	2245
9.6 Kbps Data	21000	19456	18555
56 Kbps Data	36516	35498	35010

4.D COMPARATIVE CROSSOVER RESULTS

As previously discussed, two series of satellite service cost models were generated. The first or base case represents satellite service costs based on the Parametric Satellite Facilities Cost Model results. The second or + 20% case represents satellite rates increased by 20% to reflect a cost advantage satellite rates scenario.

As discussed previously, terrestrial service rates are projected to decline at an average annual rate of 1%. Beginning with current tariff rates by service, each rate is declined over the 1978-2000 period at that constant 1% level.

The comparison of the two, satellite and terrestrial costs, is made for each service and for three time periods. The point where the satellite rate (either base or + 20% case) is equal to terrestrial rates is called the break-even point. These break-even points for 1980, 1990 and 2000 are shown in Tables V-16, V-17, and are displayed graphically in Figures V-4 to V-7.



SATELLITE SERVICE COST DISTRIBUTION

VOICE CHANNEL

FIGURE V - 3

Table V-16 - Parametric Cost Model Breakeven Distances
Expressed in Service Channel Miles
C-Band Services

		MILES	
BASE CASE	1980	1990	2000
Voice	480	450	390
300 Baud Data (Low)	60	30	20
9.6 Kbps Data (Medium)	180	50	30
56 Kbps Data (High)	1890	1660	1430
+ 20% CASE			
Voice	630	590	530
300 Baud Data (Low)	100	70	50
9.6 Kbps Data (Medium)	420	240	100
56 Kbps Data (High)	2500	2320	2050

Table V-17 - Parametric Cost Model Breakeven Distances
Expressed in Service Channel Miles
Ku Band Services

		MILES	
BASE CASE	1980	1990	2000
Voice	800	800	780
300 Baud Data (Low)	80	60	40
9.6 Kbps Data (Medium)	1360	1300	1120
56 Kbps Data (High)	210	210	220
+ 20% CASE			
Voice	1030	1030	990
300 Baud Data (Low)	130	100	80
9.6 Kbps Data (Medium)	2100	2060	1850
56 Kbps Data (High)	370	370	390

VOICE CHANNEL

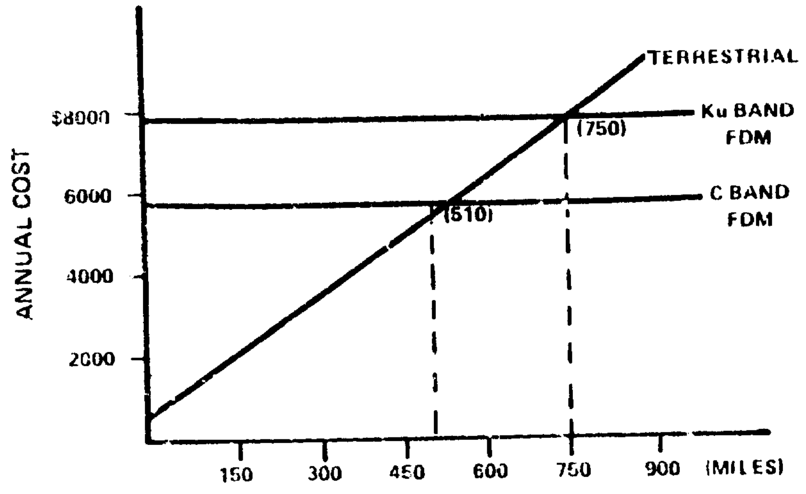


FIGURE V-4

MEDIUM SPEED DATA
9.6 KBPS

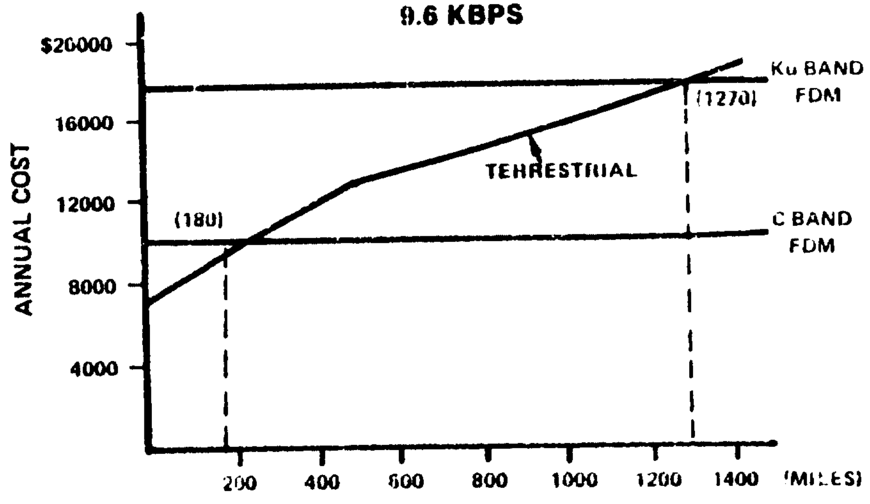


FIGURE V-5

SATELLITE SERVICE CROSSOVER POINTS
(LOWEST COST ALTERNATIVE FOR C AND Ku BAND)
1980

LOW SPEED DATA
(300 BPS)

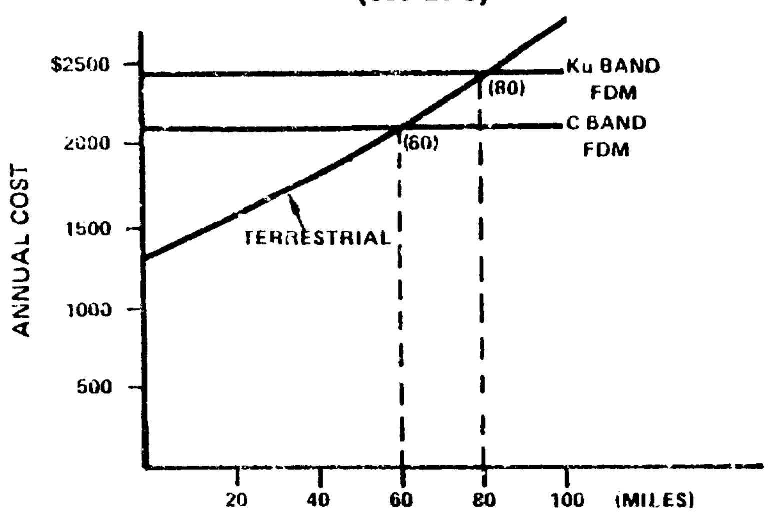


FIGURE V-6

HIGH SPEED DATA
(56 KBPS)

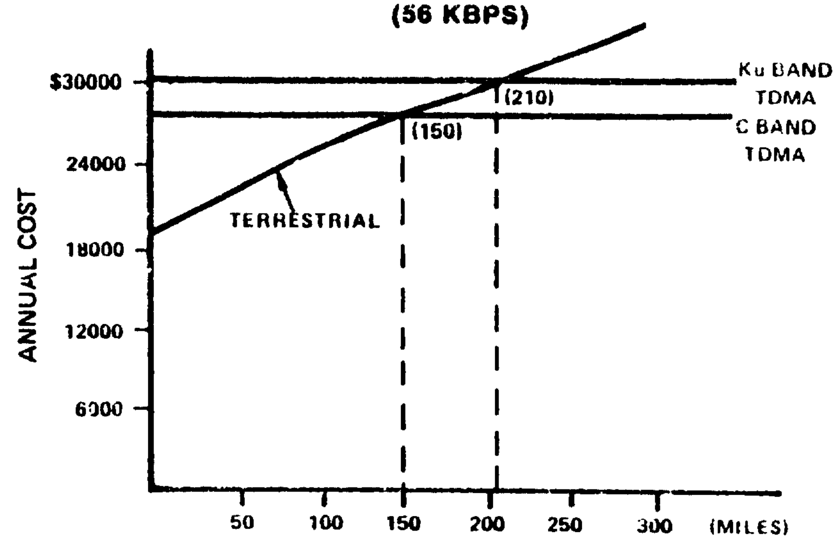


FIGURE V-7

SATELLITE SERVICE CROSSOVER POINTS
(LOWEST COST ALTERNATIVE FOR C AND Ku BAND)
1980

5.0 SIGNIFICANT CONCLUSIONS

5.A SATELLITE SERVICE COST TRENDS

Currently, a single voice grade circuit provided by a domestic satellite carrier can be leased for about $750 per month, including termination costs. However, due to widespread use of multi-channel discount arrangements, the average rate is closer to $600 per month. The Parametric Facilities Satellite Cost Model projects that by 1980 the same voice circuit may lease for about $500 per month. While the two costs are not directly comparable, they are indicative of an important trend.

Satellite service costs are on a declining trend. Many factors will account for this trend continuing in the 1980's and 1990's. The model projects a monthly rate per VF of around $385 by year 2000, a decline of almost 25% from 1980.

Satellite service costs can be expected to decline because of rapid advances in satellite and earth station technology, introduction of the space shuttle launch services, improvements in spacecraft power generation, and smaller, lower cost earth stations. A secondary factor influencing service rates is the increasing system traffic fill which produces important operating economies.

The area where cost may not show favorable trends during this time period is in local loop facilities to connect to user premises. The concerns about their cost and availability, especially digital loops, may result in an increased attractiveness of direct-to-user earth stations which can bypass local Telco loops and provide wideband transmission services.

The decline in Ku-band service cost is not projected to be as great as the decline in C-band cost. For example, a medium speed (9.6 Kbps) data channel via Ku-band is projected to decline from $1450 per month in 1980 to around $1300 by year 2000. The lower rate of decline is due to two factors: first, cost of a Ku-band satellite system is projected in the model to be more than twice as high per transponder as C-band; second, the average projected fill on the Ku-band satellite is lower than C-band resulting in lower operating utilization. Over the 7 year satellite life, Ku-band transponders will cost more in order to recover the investment over a smaller projected average traffic load.

5.B SERVICE COST CROSSOVER DISTANCES

The Parametric Facilities Cost Model indicated that the crossover distance for a C-band voice circuit in 1980 is 480 miles; a low speed data channel is only 60 miles; while a high speed data channel is 1890 miles. The wide variances in crossover distances are due to satellite efficiencies or inefficiencies when compared to terrestrial delivery systems. Terrestrial tariffed private line voice circuit rates are linearly proportional to channel distance, that is, the greater the distance, the higher the total cost. Satellite service, as postulated in this model, is, for the most part, distance insensitive.

The satellite has been found to be more efficient for low speed (300 bps) data service. Utilizing a single voice channel, a total of 20 low speed data circuits may be derived. In addition to this efficiency, terrestrial rates for low speed channels are almost equivalent to voice-grade facilities.

Wideband (56 Kbps) data channels are inefficiently derived in an FDM environment. It is assumed in the model that twelve voice channels are required to derive a single 56 Kbps data channel. Also, a digital loop is required at each circuit end. This inefficiency is translated into a longer crossover distance versus terrestrial digital data service. Significant improvement in the crossover distance, to 150 miles, occurs when a TDMA approach is used. In this digital approach, the allocated cost is equivalent to a single VF channel. Relatively high terrestrial rates even for short distances produce the very low crossover distances.

5.C SERVICE DEMAND INFLUENCES

It is anticipated that over time, an increasing amount of communications users will become fully aware of the cost efficiencies of satellite service. This will result in more traffic being carried on domestic satellite systems as well as facility savings to customers.

However, market studies of communications users do indicate that other factors play an important role in the decision to lease transmission lines. A few of these other purchasing decisions are:

- Geographic availability of service
- Service quality/reliability
- Satisfaction with existing service use
- Potential necessity for software conversion to accommodate satellite data
- Intensive sales and advertising efforts by competitors.

These issues and their impact on the potential traffic demand for satellite services are addressed in greater detail in Section 5.C.

5.B PRESENT AND PROJECTED TERRESTRIAL TAILS COSTS LINKING 18/30 GHZ EARTH TERMINALS

1.0 STATEMENT OF WORK

The contractor shall estimate year 1980, 1990 and 2000 costs per circuit mile of the terrestrial "tails" linking users with 18/30 GHz earth terminals. The "tails" to be considered shall be: a direct microwave link between the user and the terminal, coaxial cable millimeter waveguide, fiber optic cable, and the telephone system.

2.0 INTRODUCTION

The planned use of higher power, and higher frequency satellites in the next two decades will permit the use of more cost effective earth terminals for transmit and receipt of communication services. A reduction in one element of a satellite delivery system, namely the earth terminal cost causes attention to turn to the links which connect the earth station to the user's premises. Today, almost all entrance links consist of 4/6 GHz analog microwave systems. As new technologies such as fiber optics and millimeter waveguide become tested, developed commercially and proven in use they will begin to be employed in a number of unique applications, including earth station entrance links with end users.

This cost analysis task is designed to evaluate the relative present and projected costs for alternative delivery systems, capable of high capacity transmission, between 18/30 GHz terminals and switching centers or user premises.

3.0 METHODOLOGY

3.A. APPROACH

Utilizing a variety of sources, including internal Western Union technical studies, consultant analyses and technical research articles, the cost elements for each of the four interconnect systems have been developed. From these and other sources, projections have been made as to the general cost trends, in 1978 dollars, of these transmission systems over the 1980-2000 period. Each of these competing systems have specific technical advantages which have been considered in the cost analysis.

The terminal interconnect systems which have been analyzed are:

- Direct Microwave Link
- Coaxial Cable
- Fiber Optic Cable
- Analog Telephone System

For each of the systems, except for the local telephone system, the total cost for a complete transmission link was developed taking into consideration total circuit capacity. Furthermore, they were broken down into cost per circuit mile based on a reasonable distance separating the earth terminal from the switching center.

3.B DIRECT MICROWAVE LINK

A number of digital microwave radio systems have made the transition from the test laboratory to actual commercial operation. Not only in the U.S., but throughout the industrialized world, nations have seen the advantages of digital microwave. Table V-18 is a summary of the varieties of digital system currently in use or planned for operation.

AT&T, for example, began offering its Dataphone Digital Service via its analog microwave network using a Data Under Voice technique. A major microwave route of 16 radio channels was made to support up to sixteen 1.544 Mbps channels or more than 24 Mbps of digital throughput.

The main advantage of a digital microwave system is that it transmits data signals without the use of voice grade modems. Perhaps a more important feature of the digital system is the maximum data rate. The data rate of an equivalent voice channel in a digital system is about 64,000 bps. The maximum data rate available over voice grade modems is 9600 bps, therefore, the efficiency of a digital system is at least six times greater than that of the analog system.

The principal cost advantage of digital microwave systems is principally in the multiplex equipment. The cost difference in that area can run as high as 3 to 1 versus analog microwave systems.

The digital radio system assumed in the cost model was a MDR12-5 system shown in Figure V-9. This system provides for 44.7 Mbps two-way digital transmission and can generate 28 DS-1 (1.544 Mbps) channels, 7 DS-2 (6.312 Mbps) signals or combinations of either signals.

The digital microwave system is assumed to be employed on a single hop route to connect the earth terminal to a central office location. Its capacity in voice channels is about 1332 VF's, one-way (667 VF's duplex) with each voice channel utilizing a 64 Kbps slot (without use of DSI techniques).

The direct digital microwave model costs are detailed in Table V-19.

Table V-18 Digital Microwave Radio Systems in Use or Planned

Country	Frequency Band (GHz)	Transmission Rate (Mbps)	Modulation
U.S.	6	40 - 90	QPSK, 8-Phase PSK
U.S.	11	40 - 90	QPSK, 8-Phase PSK
U.S.	18	274	QPSK
Japan	2	15	QPSK
Japan	4	24	QPSK
Japan	11	200	8-Phase PSK
Japan	15	200	QPSK
Japan	20	400	QPSK
Italy	13	35	QPSK
Canada	8	90	Partial Response QPSK

Table V-19 Direct Microwave Link
90 Mbps (One-Way) Digital Radio
(000's)

Radio	73
Fault/Alarm	16
Antenna and Waveguide	18
Civil Works	22
Towers	17
Test Equipment	24
Power	26
Land Lease	3
Site Selection	7
Labor and Overheads	18
	\$ 224 per end
	x 2
Total Cost	\$ 448
Equivalent VF Capacity	1332

BLOCK DIAGRAM OF DIGITAL MICROWAVE SYSTEM

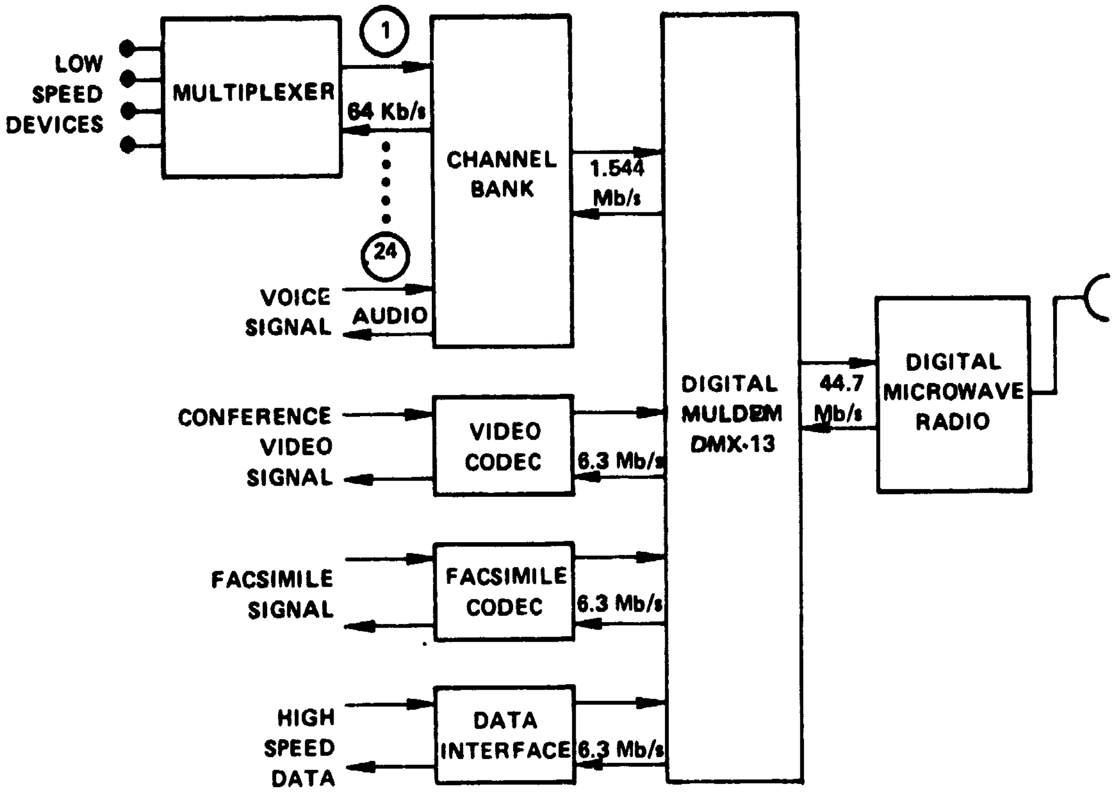


FIGURE V-9

3.C FIBER OPTIC CABLE

Today, fiber optics offer a new, efficient, and cost effective method of interfacing data communication equipment. Aside from rapidly dropping cost, fiber cable often proves to be technically superior to either twisted pair or coaxial cable. Some of these advantages are displayed in Table V-20.

Table V-20 Optical Cable Benefits

Feature	Advantage
Large Bandwidth	- low cost per channel
	- expansion capability
	- increased data carrying capability
Immunity to Interference and Radiation	- reliability
	- lower cross-talk
Dielectric	- electric isolation
	- elimination of ground loops
Low Loss	- improved signal attenuation
Resistant to Taps	- system security
Small Size, Low Weight	- space and weight savings

Perhaps the major advantage of fiber cable is its wide bandwidth. Because potential information carrying capacity increases directly with frequency, the availability of laser-driven fiber links provides the potential for transmitting data at speeds of up to 1013 bits per second. With bit error rates exceeding 10^9, noise immunity properties, etc., fiber optics offers a significant cost advantage in certain installations.

This cost advantage when compared with other alternatives is very apparent. A standard RS 232-C twisted cable costs from $1.00 to $1.50 per foot. Shielded cable which would be used in remote terminal installations costs approximately $1.40 per foot.

Coaxial cable costs between $1.00 (RG58-U) and $9.00 (RG-14U) per foot, based on such factors as bandwidth and shielding. A superior fiber optic cable having only a -6 dB loss and a bandwidth of 600 MHz costs approximately $0.31 per foot.

At this time, over 3000 kilometers of optical fibers are in use in various land based installations. It is only a matter of time before they are employed as interconnection links between digital earth terminals and switching centers.

While there are a variety of standard fiber cable sizes available commercially, ranging from 20 Mbps to more than 245 Mbps, a four fiber 90 Mbps system was chosen to match the capacity of the 6 GHz digital microwave (1332 equivalent VF's).

A fiber optics transmission link includes the following components:

- Transmitters
- Fiber cable
- Receivers
- Connectors, splicers and couplers

Costs of fiber optic components are dropping rapidly as a result of a new technological development and larger production quantities. Cost estimate projection versus time for fiber cable and connectors is shown in Figure V-10.

Table V-21 shows costs per meter in 1978 dollars exclusive of installation for a four-fiber cable interconnect link. Repeaters would be spaced at 4 kilometer intervals and cabling cost is based on a maximum capacity for six fibers per cable. The four fibers provide for a single fiber one-way capacity of 90 Mbps and a redundancy of one fiber for each one-way fiber, for a total duplex capacity of 90 Mbps.

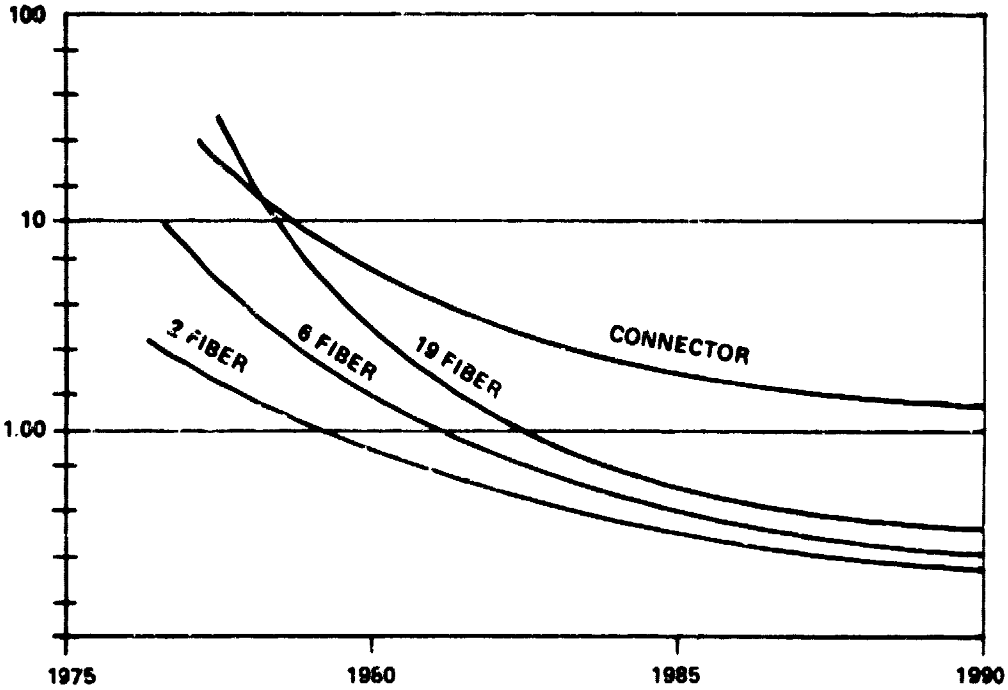
Table V-22 shows the total cost per meter including installation in 1978 dollars. The installation cost represents a situation where the right-of-way already exists but there are high installation costs, as in a downtown area.

Table V-21 Fiber Optic Interconnect Cost Per Kilometer
1978 Dollars
Exclusive of Installation

4 Fiber/90 Mbps (Duplex Capacity)

Fibers ($1180/fiber)	$ 4,720
Cabling Cost	1,500
Repeater	1,000
Connectors	80
Total Cost	$ 7,300/Kilometer

FIBER OPTIC COST TRENDS



SOURCE: JEFF MONTGOMERY "WORLDWIDE BUSINESS OPPORTUNITIES IN FIBER OPTIC COMMUNICATIONS". FIBER AND INTEGRATED OPTICS, VOLUME 1, 1977.

FIGURE V-10

Table V-22	Total Installed Fiber Optic Cost Per Kilometer 1978 Dollars
Equipment Cost	$ 7,300
Average Installation Per Kilometer	7,000
Total Installed Cost	$14,300

3.D COAXIAL CABLE

Coaxial cables are used to carry a substantial portion of long haul circuits and switched network trunks on terrestrial systems. In addition, it is finding increasing use for digital and analog trunks in metropolitan networks. Although the cost of coaxial cable is higher than paired cable, its adaptability to very broadband systems makes it valuable for providing service on heavy traffic routes. The per channel mile cost of such systems is relatively low, providing the traffic fill is relatively high.

Coaxial systems are used primarily in the long-haul plant to provide services over distances of a few hundred up to about 3000 miles. Recent installations have been made worldwide with transmission rates as high as 640 Mbps.

The coaxial cable is made up of 4 to 22 coaxial copper-wire pairs and single wires all wound around the cable axis in overlapping strands. Standard diameters for these coaxial units is .375".

Transmission systems are designated by "L" units. Beginning in 1946, the number of coaxials per cable has risen from one or two to later designs consisting of 12,20, 22 coaxials for use in L3, L4, and L5 systems.

The principal features of existing coaxial cable systems are shown in Table V-23. Each system, starting from the L1, evolved to the complexity in use today, over a 30 year period.

Table V-23		Coaxial System Features		
System	Number Cable Units	Nominal Bandwidth MHz	One-Way Channels Per Coaxial Pair	Noise Objective dB
L1	4- 8	3	600	44
L3	8-12	8	1360	44
L4	12-20	17	3600	40
L5	12-22	57.5	10800	40
L5E	12-22	61.5	13200	40

3.E TELEPHONE SYSTEM

It is difficult, if not impossible, to compare the capabilities of digital wideband facilities such as fiber optics, coaxial cable and digital microwave to the analog telephone facilities available as terrestrial tails. Essentially, the telephone system is designed for voice transmission within exchange or interexchange centers. That plant is normally only available in individual channel units for four-wire voice.

There are four alternatives which were examined for wideband analog facilities. Unfortunately, none are either available for earth station interconnection or their cost would be dependent on many factors and conditions which cannot be pre-specified.

Telpak "C" service representing a bandwidth of 240 KHz on an unchannelized basis is only available to existing Telpak customers. Based on a previous FCC decision, Telpak may also be eliminated shortly, and therefore, this alternative cannot be considered for earth station interconnection purposes.

Wideband analog channels (240 KHz) have been leased, through special arrangements, only to other common carriers and are limited to only a very few routes. The rates currently being charged to other common carriers would not be the same as charged to end users, if the wideband facility was available to them.

4.0 COST ANALYSES RESULTS

The evaluation of the terrestrial tail systems costs accounted for total installed cost elements as well as system capacity. While maximum fill level on the transmission facility was assumed, it becomes a critical variable in the cost per circuit mile comparisons. Another area of consideration is the length of the interconnection link. While nominal distances for each transmission system were assumed, presently microwave radio and coaxial cable are used predominately for long hauls in excess of 50 miles. Perhaps in the future, when costs decline much further, these systems may be used for short haul applications.

Fiber optic cable, on the other hand, has been used, so far, for local distribution purposes and it may be several years before the first intercity fiber cable system will be installed.

4.A DIGITAL MICROWAVE LINK COST

The total capacity for the 6 GHz digital microwave system was 667 duplex voice channels. An assumption was made that the distance between the 18/30 GHz earth terminal and end user location would be one hop or about 20 miles.

Thus the following conversion was made to translate the digital radio system cost into a current cost per circuit mile (Table V-24).

Table V-24 Digital Radio Conversion Cost

Total Digital Radio Cost	$ 448K
Cost Per Circuit (667 VF's)	$ 670
1978 Circuit Cost per Mile (20 miles)	$ 34

It is estimated that the future of digital microwave technology will result in advances in solid state circuitry, more reliable components and greater efficiencies in its manufacture. This is anticipated to reduce the cost of such digital systems, in 1978 dollars, on a slightly declining trend.

This average declining cost per year for 6 GHz digital radio systems is predicted to be as follows:

1978 - 1980	-	10%/year
1980 - 1990	-	8%/year
1990 - 2000	-	4%/year

Applying this declining cost curve to the 1978 system cost per circuit mile will produce the following (Table V-25).

Table V-25 6 GHz Digital Radio Cost Trends (1978 Dollars)

	1978	1980	1990	2000
Per Circuit	$670	$542	$235	$156
Per Circuit Mile	34	27	12	8

4.B FIBER OPTIC CABLE COST

A very rapid decline in the cost of installed fiber optic cable systems has been projected due to a number of efficiency and market factors.

The basic cost of the system fiber cable, has dropped as multimode and multi-fiber cables have been produced as one unit. The injection lasers or light emitting diodes have advanced to very high reliability state.

For example, a single fiber cable which costs around $2 per meter in 1976 is expected to be reduced to $.30 by 1980, one-seventh the original price in 1978 dollars.

The one area where system costs may not be affected as dramatically is in the cost of installation. It has been possible to reduce somewhat the time it takes to make an installation, but labor productivity levels are not expected to yield much greater cost savings than experienced today.

The basic fiber optic system used for cost development purposes is the 90 Mbps/4 fiber cable. Based on the anticipated improvements in several system cost areas, the average cost for the fiber optic system, except for installation, is expected to drop by 40% by 1980, a further 20% between 1980 and 1990 and another 7% by the year 2000. Installation related costs may only decline at a 5% rate per year. The results of the cost projection analyses for a fiber optic system are shown in Table V-26, and for a cost per circuit mile in Table V-27.

Table V-26 90 Mbps Fiber Optic Conversion Cost

Installed Cost/Kilometer	-	$ 14,300
System Cost/Mile (x 1.609)	-	$ 23,000
1978 Circuit Cost/Mile	-	$ 34.4

Table V-27 Fiber Optic Cost Trends (1978 Dollars)

	1978	1980	1990	2000
Per Mile (000's)	$23.0	$14.3	$ 6.5	$ 4.5
Per Circuit Mile	34	21	10	7

4.C COAXIAL CABLE COST

Coaxial cable systems have been implemented for a number of years by the major telephone companies to provide long haul, large capacity transmission. The technology for coax, while already mature, has improved through means of increasing the number of tubes per cable and reducing its cost of installation.

Starting with the L1 cable capacity of 600 channels, the most current cable, the L5E, has 22 times the capacity at about five times the smaller unit's cost. This has brought down the average cost per channel.

Installation and connections have been made simpler by use of standard cable laying equipment, less frequent need for regeneration and cable sheathing more resistant to electrical interference.

These cost reduction trends are expected to continue in the future, but perhaps on a lesser scale.

The representative coaxial cable unit selected for terrestrial interconnect cost comparison is the L3 system, with a one-way capacity for 1360 channels per coaxial pair.

Analysis of its current costs, as incurred by the Bell System, indicates a cost per mile very comparable to a digital microwave link. As Table V-28 shows, coaxial cable costs are expected to decline at about 3% rate between 1978 and 1980, 2% rate between 1980 and 1990, and a 1% rate to the end of the century, all in 1978 dollars.

Table V-28 L-3 Coaxial System Cost Trends (1978 Dollars)

	1978	1980	1990	2000
Cost Per Mile (000's)	$51.7	$48.5	$39.7	$35.9
Cost Per Circuit Mile	$38	$35	$29	$27

5.0 CONCLUSIONS

Cost trends for short and long haul transmission are on a projected downward trend while transmission capacity is steadily increasing. The effects of solid state, micro-electronics, large scale production are directly impacting transmission equipment costs favorably.

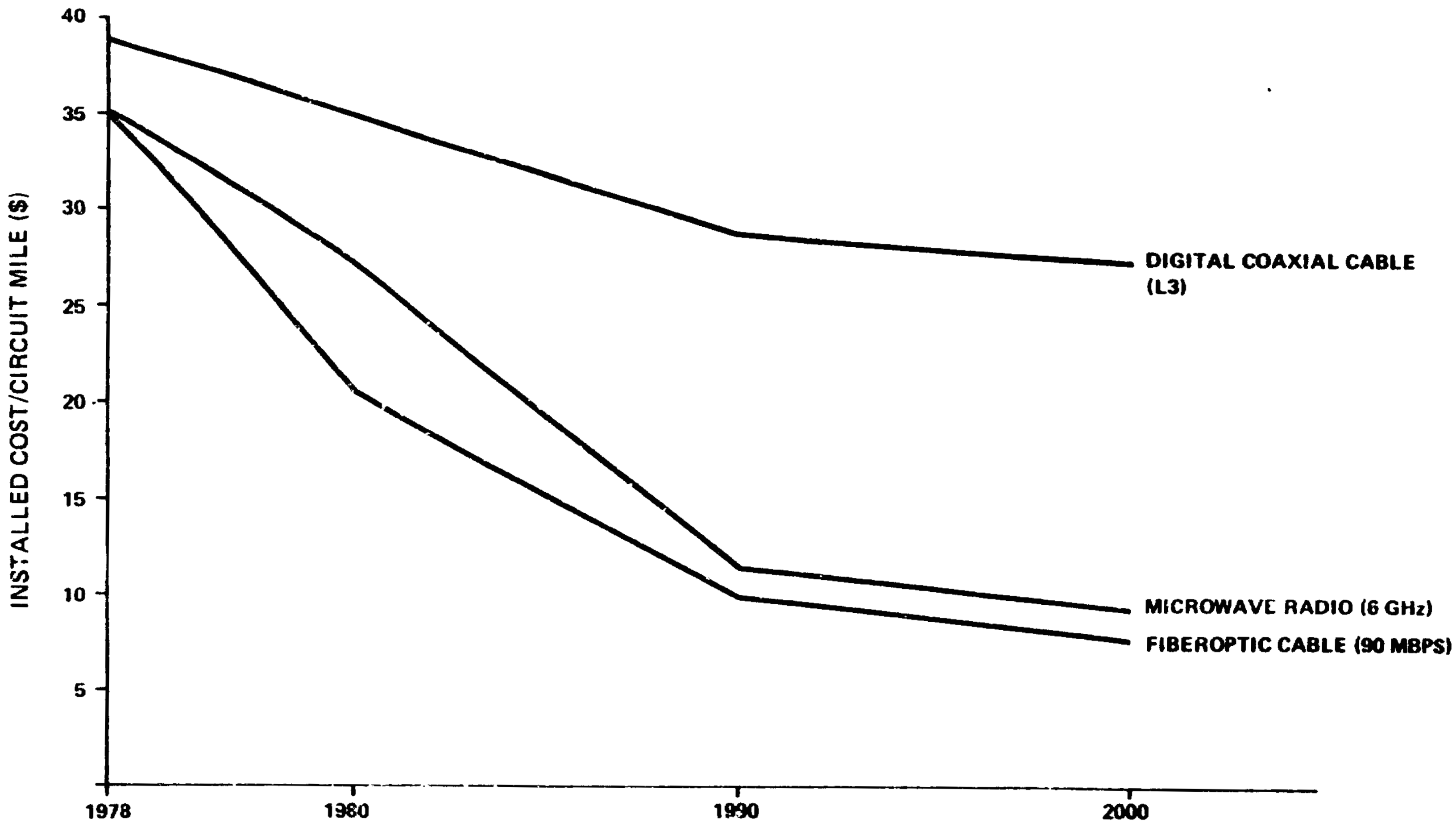
To be cost effective for use as an interconnection link for 18/30 GHz satellite service, the traffic requirements and fill level must be high. The cost comparisons, either per circuit or per circuit mile, are based on a 100% fill of each system. Lower saturation levels will drive up the per circuit cost correspondingly.

Such items as line terminations, receivers, transmitters, regenerators are among the elements that will be impacted by technological advances in the future. Other costs are much less controllable, such as right-of-ways, installation personnel, and site surveys, and will only decline with improved productivity.

A comparison of the end link costs for the three system alternatives is shown in Figure V-11 for each of three key time periods. A similar comparative analysis was developed by Bell Laboratories a few years ago and is shown in Figure V-12. The cost analysis indicates a very clear and strong relationship between cost per circuit mile and the size of the system.

Present cost proportions and system capacity patterns are such that a pair of open wires is still used for local distribution from an individual telephone to a local exchange, where many voice circuits are bundled for further short or long haul.

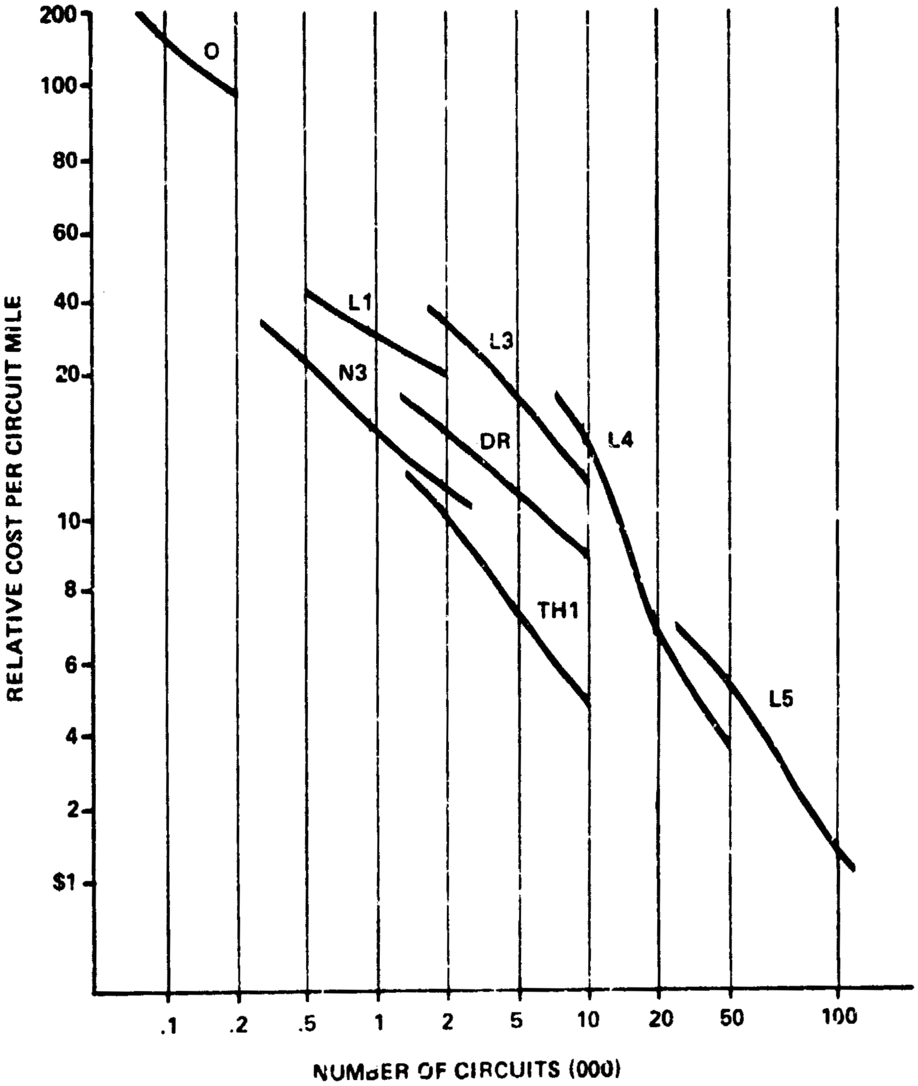
For future earth station systems, installation of smaller capacity earth stations near major cities may reduce earth station costs, but, conversely, may not permit use of high capacity, lower cost per mile interconnection link systems.



TERRESTRIAL END LINK COST COMPARISONS PER CIRCUIT MILE

FIGURE V - 11

ALTERNATIVE TRANSMISSION COSTS



KEY

CODE	TRANSMISSION	RANGE
O	OPEN WIRES	SHORT HAUL
N	CABLED WIRES	SHORT HAUL
L	COAXIAL CABLE	LONG HAUL
TH	MICROWAVE RADIO	LONG HAUL
DR	DIGITAL RADIO	SHORT OR LONG HAUL

SOURCE: BELL TELEPHONE LABORATORIES

FIGURE V-12

TASK 5.C C AND Ku BAND SATELLITE SERVICE VOLUME

1.0 STATEMENT OF WORK

The contractor shall estimate the maximum volume of service which could be provided by C and Ku-band satellites.

2.0 INTRODUCTION

The segregation of satellite traffic from total market demand required an analysis of the net long haul traffic to determine the portion of that market which is suitable to satellite implementation. This separation is also the necessary intermediate step required in estimating the demand for C and Ku-band and 18/30 GHz satellite systems.

A number of different usage and technical characteristics, as well as cost competitiveness, were considered in the segregation of satellite traffic. One of the more influential criteria for the separation was the operational effect of satellite delay on each of the 31 service applications (previously shown in Task 2.A).

A basic assumption made for the purposes of this separation was that any traffic that is qualified for satellite implementation can be carried on a C-band, analog system with a CONUS footprint. This assumption is based on usage and technical characteristics associated with C-band satellite systems which pose the fewest barriers to traffic - particularly with regard to system availability and multipoint signal distribution. Therefore, the first separation of satellite traffic is the quantification of the net addressable C-band satellite market demand. The net addressable Ku-band satellite market demand was quantified by application of the same qualifying criteria, but with more restrictive evaluations appropriate to a higher frequency digital system operating in a point-to-point mode.

The methods of evaluating criteria for satellite suitability in this task were used again in Task 6.C, estimation of demand for 18/30 GHz system services.

The results of this task are presented in the units of measurement appropriate to each service category. In addition, the three different traffic units were converted to common units of measurement, megabits per second and equivalent 50 Mbps transponders. This permitted analysis of the proportional contribution to demand of each service category. The demand forecast represents the total traffic suitable to a particular satellite frequency rather than that which actually may be implemented. Demand associated with different satellite systems is not additive. It represents the overlapping traffic subjected to different evaluations.

3.0 METHODOLOGY

Figure V-13 is a flow diagram of the logic used to identify and quantify that portion of the net long haul traffic addressable by C and Ku-band satellite transmission. Two steps are required to separate the net addressable satellite market demand from the net long haul traffic: remove traffic with unacceptable user and application characteristics; and, remove traffic below the terrestrial/satellite cost separation distances.

Unacceptable user and application characteristics refer to usage and technical considerations which play a part in determining the suitability of a particular application for implementation on a satellite transmission system. Among the qualification criteria evaluated in determining satellite implementation suitability were the following:

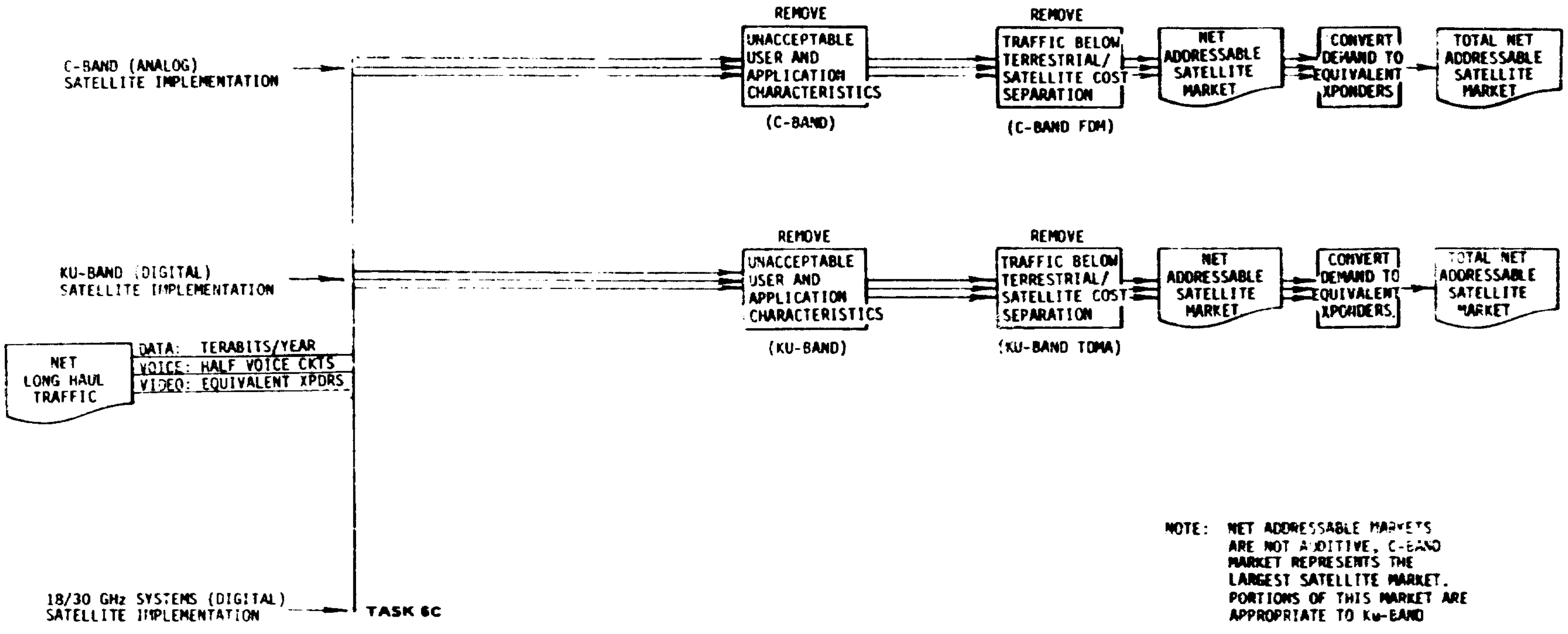
- Satellite delay. What is the ability of an application to tolerate a 600 millisecond delay caused by transmission via satellite? In data applications, this represents the delay between sending a block of information and the acknowledgement of its correct reception.

- Accommodation of satellite delay. What effect will the cost and required technology necessary to overcome some satellite delay problems have on demand? Included are the costs of software conversion or special equipment, the projection of their availability and ease of implementation.

- Multipoint signal distribution. What are the requirements of each application for broadcast-type signal distribution? The C-band CONUS coverage easily accommodates multipoint requirements such as are associated with the Network Video application, while Ku-band implementation of multipoint distribution requires a separate half channel for each additional drop. (The Ku-band system model is a point-to-point system, not adaptable to broadcast services. However, some anticipated Ku-band systems will be capable of broadcast distribution.)

- Urgency of message delivery. How tolerant will users be to service interruptions and outages in excess of that experienced on terrestrial transmission media such as the public switched network? Movement to higher transmission frequencies is accompanied by the potential for lower levels of service availability. The impact of reduced availability varies with each application.

- Miscellaneous characteristics. Several minor service considerations were also evaluated. They included: joint use of existing facilities, which may cause facility requirements to reflect the principal usage rather than the subordinate usage; and, insufficient traffic volume of a specific application to justify special communications facilities.



FLOW DIAGRAM: NET LONG HAUL TRAFFIC TO NET ADDRESSABLE SATELLITE MARKET

FIGURE V - 13

Quantification of these qualifying criteria included several conditions. Some were fundamental to the separation of satellite and terrestrial traffic (satellite delay), some were necessary to separate different forms of satellite transmission (multipoint signal distribution), and some were time oriented (accommodation of satellite delay). Each of the 31 service applications were evaluated for each characteristic in current terms (1978) and for the year 2000, based on trends established by judgement and analysis. Intermediate years also were evaluated if a significant change in trend was anticipated. A factor was established for each criterion for 1978 and 2000 which defined the proportion of market demand associated with a particular service application that could tolerate the requirements of the criterion. The individual factors derived for each criterion were consolidated into a composite qualifying factor and applied to the net long haul market demand for each application and each year of the 1978-2000 time span by computer modelling techniques. This completed the first step.

The second step in the calculation of the net addressable satellite market demand is the imposition of a cost/distance separation of traffic which removes all traffic that can be more economically implemented by terrestrial facilities. These separations were determined by the analysis and modelling associated with the parametric cost model in subtask 5.A. The separations used included a 20% cost penalty on satellite systems as an inducement which would be necessary to persuade traffic to move from conventional terrestrial implementation to satellite facilities.

The parametric cost model calculated the cost/distance separations for voice grade service and three representative speeds of data/wideband service: 300 baud, 9600 bps and 56 Kbps. Each of the four service types had four forms of costs and distance crossovers presented: C-band and Ku-band transmission each with FDM and TDMA approaches. Because the system model was predicated on an analog C-band system and a digital Ku-band system, the FDM approach in determining cost/distance crossovers was used for all service categories when analyzing the C-band market demand, the TDMA approach was used for all service categories when analyzing the Ku-band and 18/30 GHz systems market demand. This method of setting cost/distance crossovers was necessary so that each transmission system would show a consistency in establishing the separation of traffic based on costs.

The differences inherent in the cost/distance separation of terrestrial and satellite traffic between the C- and Ku-band systems causes some traffic which was qualified for C-band satellite implementation not to be qualified for Ku-band implementation and vice versa. For example, the cost/distance crossovers for wideband data services (56 Kbps and higher speeds) determined by the parametric cost model indicate an analog C-band crossover distance of 2500 miles compared to only 370 miles for the digital Ku-band system crossover. In this way, some small portion of market demand forecast for the lesser quality (as judged by usage and technical criteria) Ku-band system did not appear as a part of the C-band system market demand.

Figure V-13 also shows that to this point in the analysis, the voice, video and data service categories are handled separately and that market demand is expressed in units appropriate to the specific category (half voice circuits, wideband channels and terabits per year). The last step converts demand for each service category to equivalent 50 Mbps transponders. This step employs conversion factors distinctive to each individual application and presents demand expressed in a common unit of measurement, megabits per second (Mbps).

For this study, an equivalent satellite transponder has been equated to a net usable data rate of 50 Mbps - made up of any combination of lower speed channels. Isolation of the channels is accommodated with extra bandwidth included in an overhead allotment beyond the net 50 Mbps usable transponder capacity. (For all 1980 forecasts, analog 36 MHz C-band transponders are used as the standard of equivalence - as no Ku-band system is assumed to be in service. The principal effect of using analog transponders in 1980 is that the number of half voice circuits carried by an equivalent transponder is 1000, each using 3 to 4 KHz of spectrum).

The conversion factors transform service units of measurement into Mbps which identify the "instant network size" or the quantity of satellite facilities necessary to carry traffic at an acceptable grade of service at the system peak traffic or busy hour.

Voice service applications are expressed in units of "half voice circuits", the two-way channel between an earth station and a satellite. As previously discussed in Section 2, part 5.3, MTS voice services were converted from revenue minutes of usage to half voice circuits at a rate of 55,000 minutes per half circuit. Private line voice demand did not require any further conversion because they already expressed an instant network size. As a whole, the voice category units were converted to Mbps at a rate of 32 Kbps per half voice circuit or a total of 1560 circuits per equivalent transponder.

The video service applications were projected in terms of wideband channels which were equated to full transponders and which directly represented instant network size. Occasional video and cable television video which were originally expressed in hours of usage were converted at a rate of 1550 annual channel hours per equivalent transponder. Point-to-point applications such as Teleconferencing and Interactive Home Video were assigned an appropriate bandwidth of 30 Mbps on the digital satellite systems. Channels of smaller bandwidth were grouped in appropriate multiples to equal full wideband video channels.

Data service forecasts were generated in terabits per year, which expresses total volume of traffic for each of the 21 data applications. To convert terabits per year to Mbps, four usage scenarios were constructed and each application assigned to one specific scenario. Also, each usage scenario had a specific conversion factor assigned to it. The scenarios were as follows (with the number of data applications and the conversion factor):

- Business day oriented, two-way traffic (13) - .970
- Business day oriented, one-way traffic (2) - .485
- Off-peak oriented, two-way traffic (4) - .204
- Off-peak oriented, one-way traffic (2) - .102

Two specific data applications which illustrate the differences in usage scenario conversions are data entry and convenience facsimile. Data entry usage is characterized by real time transmission especially during busy hour periods; its conversion factor to Mbps is .970.

Convenience facsimile has a less time sensitive requirement, with use occurring at various times of the business day, and with a good deal of idle time; its conversion factor to Mbps is .485.

Calculation of the conversion factors for each usage scenario involved three elements: proportion of traffic transmitted during the regular business day or in evening hours, concentration of busy hour traffic, and an operating efficiency factor. The factors for converting to Mbps ranged from .970 to .102.

It is especially important to note that the total demand, expressed as net addressable satellite market, is independent of any specific transmission configuration or system. It is an expression of user demand at a point in time unaffected by level of system efficiency, capacity or mode of transmission.

4.0 PRESENTATION OF RESULTS: VOICE SERVICE CATEGORY

Table V-29 shows the C-band and Ku-band net addressable satellite voice market demand for the years 1980, 1990 and 2000. The percentage distribution of market demand, expressed in thousands of half voice circuits, among the five voice service category applications is also calculated.

The table shows that Private Line is the dominant voice service category application. This reflects the greater tolerance of Private Line users to the slightly lower utility of satellite implementation. In the distribution of long haul market demand among voice applications, Private Line represented 42% of the total in 1980, declining to 34% in the year 2000, because of the slightly lower than average annual growth rate (8.7%). In the C-band net addressable satellite market, the proportions ran from 76% in 1980 to 61% in the year 2000 (10.0% AAGR); in the Ku-band market, the proportions were 87% to 73%, respectively, (9.9% AAGR). The decline in Private Line representation between 1980 and 2000 is a consequence of the higher growth rates associated with the MTS (Business) application (16.0% AAGR in C-band and 15.5% in Ku-band).

The MTS (Business) application, despite its high AAGR, represents a smaller proportion of the voice category demand at each step of analysis. In the year 2000, it represented 37%, 23% and 16% of the long haul, C-band and Ku-band markets, respectively. MTS (Public) is similarly affected. The declining representation for both MTS applications partly reflects user perceptions with regard to satellite transmission acceptability for public switched networks.

The Radio Program Transmission and Mobile Radio Telephone applications represent relatively insignificant segments of total voice service category market demand. The former application exhibits great adaptability to C-band satellite implementation because of its requirement for multipoint broadcast distribution. The latter application is adaptable to both C and Ku-band systems partly in recognition of a lower user threshold for acceptable service quality - somewhat conditioned by current experience with lower service quality.

The composite average annual growth rates for the voice service category are 11.2% for C-band and 10.9% for Ku-band systems for the 20 year period between 1980 and the year 2000. C-band market demand was reduced by an average of 60% after applying the qualifying criteria and cost/distance crossovers necessary to calculate the Ku-band market demand.

Table V-29

Net Addressable Satellite Market
Voice Category - Expected Case Summary
Years 1980-2000 - Thousands of Half Voice Circuits (KHVC)

		1980		1990		2000	
	Application	KHVC	Percent	KHVC	Percent	KHVC	Percent
C-Band	Private Line (incl. TELPAK)	264	76.4	676	68.8	1776	61.1
	MTS (Public - incl. coin)	45	12.9	143	14.6	418	14.4
	MTS (Business - incl. WATS)	35	10.0	147	14.9	676	23.3
	Radio Program Transmission	neg	0.1	2	0.2	3	0.1
	Mobile Radio Telephone	2	0.6	14	1.4	32	1.1
	Total, C-Band	345	100.0	982	99.9	2905	100.0
Ku-Band	Private Line (incl. TELPAK)	124	87.1	298	80.0	824	72.7
	MTS (Public - incl. coin)	8	5.3	32	8.6	115	10.2
	MTS (Business - incl. WATS)	10	7.3	40	10.7	186	16.4
	Radio Program Transmission	neg	neg	neg	0.1	neg	neg
	Mobile Radio Telephone	neg	0.3	3	0.8	8	0.7
	Total, Ku-Band	142	100.0	372	100.2	1133	100.0

5.0 PRESENTATION OF RESULTS: VIDEO SERVICE CATEGORY

Table V-30 shows the C-band and Ku-band net addressable satellite market demand for the years 1980, 1990 and 2000 expressed in equivalent broadcast quality wideband channels.

The table shows the effect of the much greater than average annual growth rate of Teleconferencing and its growing adaptability to Ku-band satellite transmission. The AAGR for the 20 year period between 1980 and 2000 is 16.4% in the C-band system and 17.7% in the Ku-band. Teleconferencing represents approximately 75% of the video category transponder demand in the year 2000 Ku-band market. The table also shows the vastly lower market demand between C-band and Ku-band for the Network, Occasional and CATV video applications which depend on broadcast type program distribution.

The composite average annual growth rates for the video service category (for demand expressed in equivalent 50 Mbps transponders) are 6.6% for C-band and 9.6% for Ku-band systems for the 20 year period between 1980 and the year 2000. C-band market demand was reduced by between 45% and 65% as a result of the calculations which yielded the Ku-band market demand. The growth in the Teleconferencing application is individually the most responsible for the growth trends indicated in these calculations.

6.0 PRESENTATION OF RESULTS: DATA SERVICE CATEGORY

Tables V-31 and V-32 display the C-band and Ku-band net addressable satellite market demand, expressed in terabits per year, for the years 1980, 1990 and 2000. The tables consolidate the demand for the 21 data service category applications and distribute it among four primary subcategories. Also shown is the percentage representation of each element of market demand to the data category total.

The C-band market demand exhibits an increase between 1980 and the year 2000 of over thirtyfold representing an average annual growth rate of 18.8%. C-band satellite market demand represents 43.1% of the net long haul traffic in 1980, rising to 52.7% in the year 2000.

All subcategories enjoy substantial growth in C-band addressable satellite market demand - but the migration of transmission to higher speeds is particularly evident when comparing the High Speed/Wideband and Low Speed/Medium Speed segments of the Data Transmission subcategory. The High Speed segment shows a 20 year AAGR of 19.2%, slightly higher than the average of all applications, while the Low Speed segment has an AAGR of 14.2% between 1980 and the year 2000. The effect of these growths is that the High Speed segment maintains approximately 43% of total data service category market demand while the Low Speed segment drops from a 22% share in 1980 to a 10% share in the year 2000. (While the individual applications that make up these category segments have characteristics which determine growth that are not necessarily associated with terminal operating speed, the similarities are sufficient to allow the operating speed conclusion to be valid.)

Table V-30

Net Addressable Satellite Market
Video Category - Expected Case Summary
Years 1980-2000 - Wideband Channels

		1980		1990		2000	
	Application	Xpdrs	Percent	Xpdrs	Percent	Xpdrs	Percent
C-Band	Network Video	7.0	9.8	18.0	9.6	33.0	9.7
	Occasional Video	23.0	32.2	39.6	21.1	40.8	12.0
	CATV Distribution	32.0	44.8	53.2	28.3	59.9	17.6
	Teleconferencing	9.4	13.2	77.1	41.0	197.1	57.9
	Interactive Home Video	NA	-	NA	-	9.5	2.8
	Total, C-Band	71.4	100.0	187.9	100.0	340.3	100.0
Ku-Band	Network Video	0.6	2.6	1.7	1.8	3.3	1.5
	Occasional Video	4.6	19.7	9.9	10.6	12.2	5.7
	CATV Distribution	11.9	51.1	23.2	24.9	30.0	14.0
	Teleconferencing	6.2	26.6	58.4	62.7	160.1	74.6
	Interactive Home Video	NA	-	NA	-	9.0	4.2
	Total, Ku-Band	23.3	100.0	93.2	100.0	214.6	100.0

Table V-31

Net Addressable Satellite Market
C-Band - Data Category - Expected Case Summary
Years 1980-2000 - Terabits (bits x 10^{12}) per Year

	1980		1990		2000	
	Terabits	Percent	Terabits	Percent	Terabits	Percent
Data Transmission Applications (8)						
High Speed/Wideband	189	41	1402	43	6323	43
Low Speed/Medium Speed	101	22	470	15	1428	10
Interactive Transmission	61	13	583	18	3060	21
Packet Switching	5	1	22	1	467	3
Subtotal, Transmission	356	77	2477	77	11278	77
Electronic Mail Applications (8)						
Restricted Access Networks	74	16	490	15	2325	16
Open Access Networks	1	0	77	3	128	1
Subtotal, EM	75	16	567	18	2453	17
EFTS/POS Applications (2)	13	3	127	4	663	5
Miscellaneous Applications (3)	21	5	44	1	139	1
Total, All Applications (21)	464	101	3215	100	14533	101

Table V-32

Net Addressable Satellite Market
Ku-Band - Data Category - Expected Case Summary
Years 1980-2000 - Terabits (bits x 10^{12}) per Year

	1980		1990		2000	
	Terabits	Percent	Terabits	Percent	Terabits	Percent
Data Transmission Applications (8)						
High Speed/Wideband	115	46	635	31	4343	48
Low Speed/Medium Speed	37	15	162	8	516	6
Interactive Transmission	49	20	291	14	1286	14
Packet Switching	3	1	14	1	235	3
Subtotal, Transmission	204	82	1102	54	6380	71
Electronic Mail Applications (8)						
Restricted Access Networks	31	12	131	6	870	10
Open Access Networks	0	0	659	32	788	9
Subtotal, EM	31	12	790	38	1658	19
EFTS/POS Applications (2)	7	3	56	3	445	5
Miscellaneous Applications (3)	8	3	97	5	498	5
Total, All Applications (21)	249	100	2045	100	8980	100

Other subcategories which show 20 year growth rates in excess of the average associated with the data category composite are the Interactive Transmission segment, 21.6%; Packet Switching segment, 25.6%; EFTS/POS, 21.7%; and the Open Access Networks segment of Electronic Mail, growing from 1 to 128 terabits per year in the 20 year period. The Interactive Transmission segment exhibits a greater growth rate over the 1980-2000 time period in C-band addressable market demand (21.6%) than that shown by the net long haul traffic market (18.2%). EFTS/POS applications have similar operational expectations. Packet Switching and the Open Access Network segments show rapid growth because they contribute so modestly to total market demand in 1980.

The Ku-band market demand grows over 35 times in the 20 year period between 1980 and 2000 representing an AAGR of 19.6%. Ku-band market demand represents 53.7% of C-band demand in 1980, rising to 61.8% in the year 2000.

The growth rates established for applications in the Ku-band market are very similar to those described for the C-band market. However, demand varies in applications where digital wideband facilities are required and analog implementation (via C-band satellite systems) incurs a cost/distance penalty. Examples of applications where Ku-band demand exceeds C-band demand are Data Transfer, USPS EMSS, Special Purpose Facsimile and Secure Voice. In the case of the USPS EMSS application (Open Access segment of the Electronic Mail subcategory), the Ku-band demand is almost 6 1/2 times the C-band demand. Similarly, the High Speed/Wideband segment and the Miscellaneous subcategory enjoy increased representation in the data services category market demand.

Tables V-33 and 34 show the C-band and Ku-band net addressable satellite market demand expressed in megabits per second for the years 1980, 1990 and 2000. Demand for the four main subcategories is also shown separately.

The distribution of demand among the four subcategories is similar to that shown in the previous tables, where demand was expressed in terabits per year.

The average annual growth rate for C-band demand for the 20 year period between 1980 and the year 2000 is 19.0%. For the Ku-band demand the 20 year AAGR is 18.6%.

7.0 CONSOLIDATED RESULTS AND CONCLUSIONS

Tables V-35 and V-36 show the C-band and Ku-band net addressable markets for the years 1980, 1990 and 2000 for the voice, video and data service categories, expressed in units of measurements specific to each service category. The data service category forecasts are also shown in megabits per second as a reference preparatory to converting the market demand to equivalent 50 Mbps transponders. These tables are a summary of information presented in the previous sections of this subtask.

Table V-33

Net Addressable Satellite Market
C-Band - Data Category - Expected Case Summary
Years 1980-2000 - Megabits per Second

	1980		1990		2000	
	Megabits	Percent	Megabits	Percent	Megabits	Percent
Data Transmission Applications (8)	233	75	1576	75	7565	75
Electronic Mail Applications (8)	62	20	414	20	1896	19
EFTS/POS Applications (2)	6	2	73	3	466	5
Miscellaneous Applications (3)	10	3	25	1	99	1
Total, All Applications (21)	310	100	2088	99	10026	100

Table V-34

Net Addressable Satellite Market
Ku-Band - Data Category - Expected Case Summary
Years 1980-2000 - Megabits per Second

	1980		1990		2000	
	Megabits	Percent	Megabits	Percent	Megabits	Percent
Data Transmission Applications (8)	115	75	619	67	3199	69
Electronic Mail Applications (8)	30	19	178	19	702	15
EFTS/POS Applications (2)	4	3	44	5	297	6
Miscellaneous Applications (3)	4	2	79	9	436	9
Total, All Applications (21)	152	99	920	100	4633	99

Table V-35

Net Addressable Satellite Market Demand
C-Band - Expected Case - Years 1980-2000
Forecasts Summary

Service Category	1980	1990	2000
Voice (Half Circuits x 1000)	345	982	2905
Video (Wideband Channels)	71	187	340
Data (Terabits/Year)	464	3215	14533
Data (Megabits/Second)	(310)	(2088)	(10026)

Table V-36

Net Addressable Satellite Market Demand
Ku-Band - Expected Case - Years 1980-2000
Forecasts Summary

Service Category	1980	1990	2000
Voice (Half Circuits x 1000)	142	372	1133
Video (Wideband Channels)	23	93	214
Data (Terabits/Year)	249	2045	8980
Data (Megabits/Second)	(152)	(920)	(4633)

Figure V-14 shows the proportions of the net long haul market demand suitable to C-band satellite systems. Both the net long haul traffic and net addressable C-band satellite market demand forecasts have been converted to equivalent 50 Mbps transponders in the manner described earlier. Because of the much greater market demand associated with the voice service category, the vertical scale used is 20 times that used for the video and data service categories.

A number of relationships are made more clear in the information as presented in the figure.

- All three service categories exhibit a time-oriented improvement in the proportion of long haul traffic which is suitable for satellite implementation.

- The video and data service categories show the greatest suitability for satellite implementation, leading the voice category by approximately a factor of three.

- Voice category demand dominates total demand, representing 82%, 76% and 80% of the total C-band demand in 1980, 1990 and the year 2000, respectively.

- The composite proportion of net long haul market demand represented by the three service categories in suitable C-band demand is 18.5%, 22.2% and 24.4% in 1980, 1990 and the year 2000, respectively.

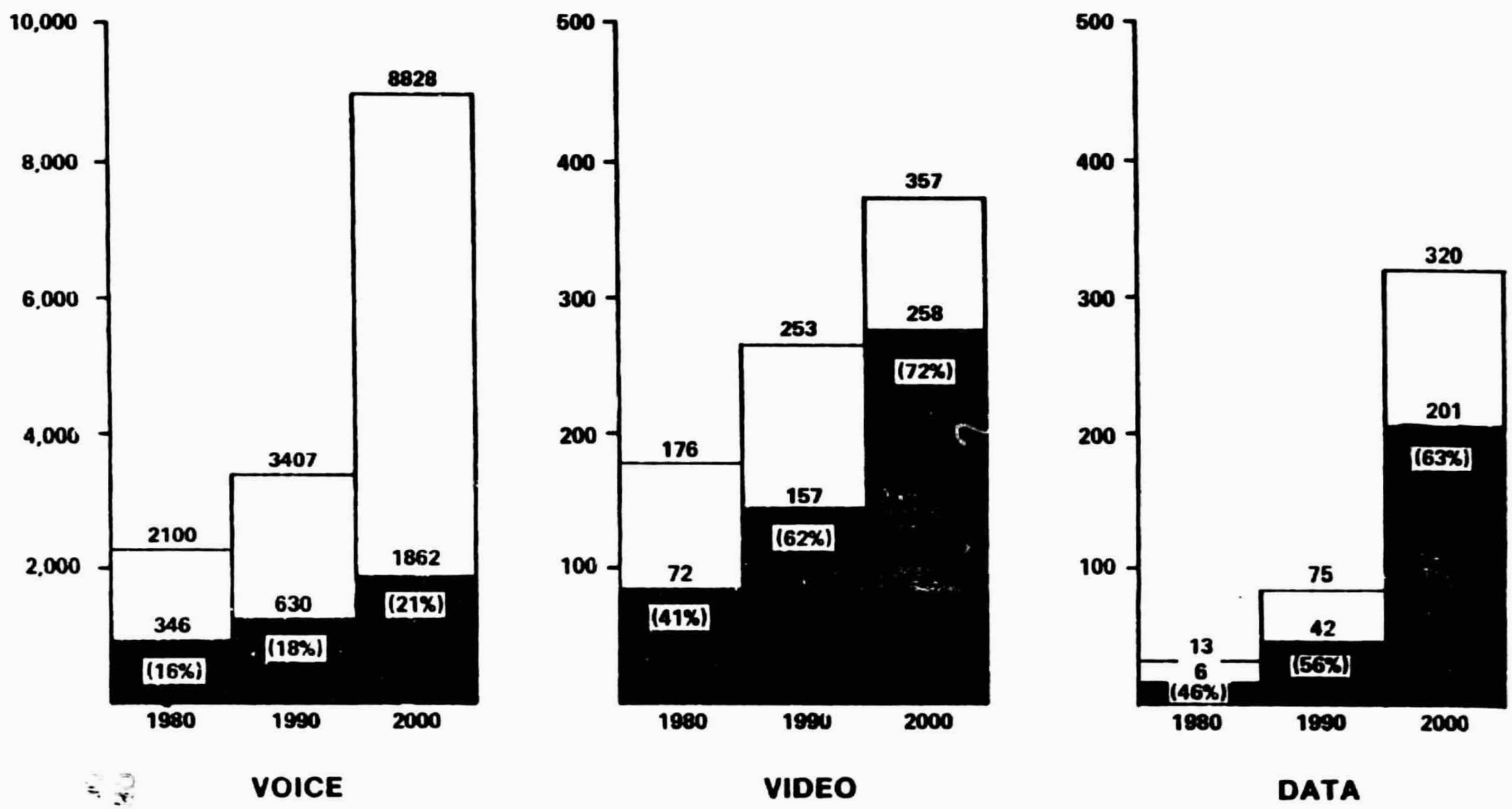
Table V-37 shows the demand for the three service categories, expressed in equivalent 50 Mbps transponders, for the C-band and Ku-band net addressable satellite markets for the years 1980, 1990 and 2000. The net long haul traffic market demand is shown for reference purposes.

The comparison between long haul traffic and the C-band net addressable market was described previously in the analysis of Figure V-14. Some relationships between the C-band and Ku-band net addressable markets can be drawn from the information contained in this table (V-37).

- Voice category demand still dominates total Ku-band demand - but to a slightly lesser extent than was the case in C-band, (75% versus 80% in the year 2000).

- Ku-band demand is increasing more rapidly than C-band (or long haul) demand. The average annual growth rate for the total Ku-band net addressable satellite market is 11.0% for the 20 year period between 1980 and 2000. The C-band AAGR is 8.9% (and the net long haul AAGR, 7.4%).

- The relative size of the total Ku-band market demand is 28%, 40% and 42% the size of the C-band demand for 1980, 1990 and 2000.



PROPORTIONS OF NET LONG HAUL TRAFFIC ADDRESSABLE BY C-BAND SATELLITE SYSTEMS

(EQUIVALENT TRANSPONDERS)

FIGURE V-14

Table V-37 Net Addressable Market Demand Forecasts
Years 1980-2000 (Equivalent 50 Mbps Transponders)

Market	1980	1990	2000
Net Long Haul			
Voice	2100	3407	8828
Video	176	253	357
Data	13	75	320
Total	2289	3735	9505
C-Band Satellite			
Voice	346	630	1862
Video	72	157	258
Data	6	42	201
Total	424	829	2321
Ku-Band Satellite			
Voice	92	239	727
Video	24	70	147
Data	3	19	93
Total	119	328	967

SECTION 6

TASK 6 18/30 GHz COMMUNICATIONS SERVICE DEMAND FORECASTS

INTRODUCTION

Task 6 identifies and quantifies the net addressable satellite market demand for 18/30 GHz systems for the years 1990 and 2000. The methodology employed segregates the net long haul market into segments which exhibit elastic or inelastic demand based on such criteria as potential 18/30 GHz systems reliability, availability, non-real time message delivery and comparative pricing. Parallel with this detail analysis on the constituents of the long haul market, additional analyses were conducted to determine the sensitivity of service pricing on demand when coupled with these operational and usage criteria.

METHODOLOGY

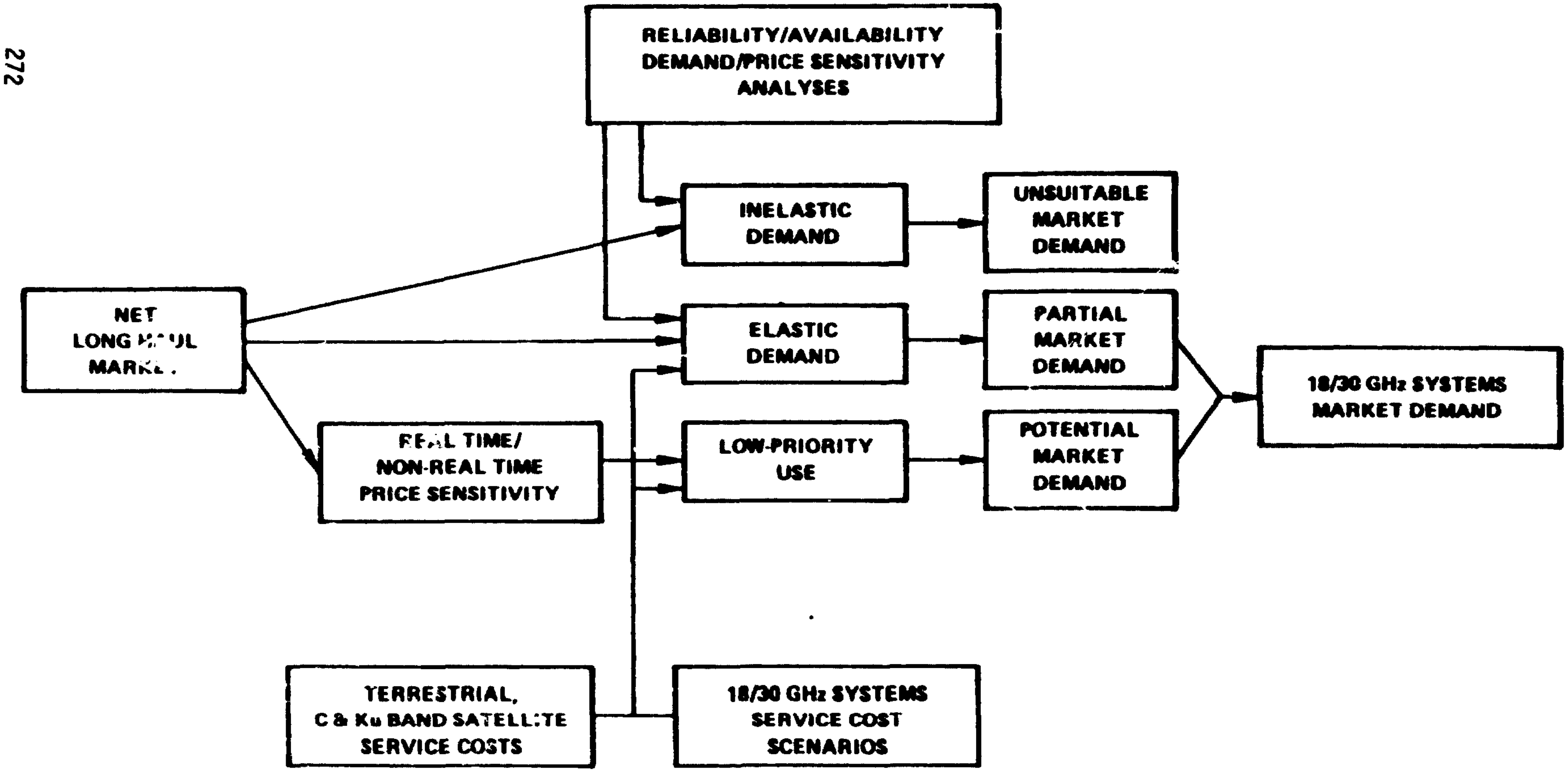
Figure VI-1 traces the methodology used in forecasting 18/30 GHz systems market demand.

Subtask 6.A provides an assessment of each service application to determine which exhibit inelastic demand when subjected to a decrease in reliability or availability and which could retain some portion of the original demand in spite of such a decrease. Subtask 6.B.1 provides the reliability/availability demand/price sensitivity analyses which correlate the potential changes in the elastic demand as a result of varying changes in service prices.

Subtask 6.B.2 provides for the identification of service applications with low-priority use characteristics and an analysis of real time/non-real time price sensitivity to market demand. Included in the analysis are correlations of varying delays in message delivery and pricing incentives.

Subtask 6.C provides an evaluation of the market demand addressable by 18/30 GHz systems among those applications judged to exhibit elastic demand for lower system availability or having low-priority use characteristics. Additional criteria are included in the analysis. Terrestrial, C and Ku-band satellite service costs, analyzed and quantified in subtasks 5.A and 5.B, are a major qualifying factor in the determination of 18/30 GHz demand forecasts. Service seenarios for 18/30 GHz systems were developed to reflect possible alternatives of service price and quality in lieu of firm 18/30 GHz system design parameters, which were beyond the scope of this study.

Task 6 was concluded with market demand forecasts for 1990 and 2000 for 18/30 GHz systems which were derived from the quantification of the partial and potential demands associated with individual applications exhibiting elastic demand or low-priority use characteristics.



18/30 GHz/Ku BAND COMPARISONS

- PRICE & SERVICE QUALITY EQUAL
- PRICE EQUAL, QUALITY LOWER
- PRICE 30% LOWER, QUALITY LOWER

ACTIVITY FLOW — 18/30 GHz SERVICE DEMAND

FIGURE VI-1

TASK 6.A SERVICE DEMAND AS A FUNCTION OF RELIABILITY

1.0 STATEMENT OF WORK

The contractor shall estimate the demand for voice, video and data services based upon present service costs for the time period 1980-2000 with reliability as a parameter. The range of reliability to be considered is 99.0 - 99.99 percent with specific points at 99.0, 99.5, 99.9, and 99.99 percent. The contractor shall provide an assessment of services that are acceptable at these reliabilities and estimate the total demand for them for the years 1980, 1990 and 2000.

The purpose of this task is to identify those service applications which require high reliability and thus would likely be restricted to trunking system configurations, and also those service applications which can tolerate interruptions and outages and may be served via a direct-to-user system.

2.0 INTRODUCTION

The acceptable level of reliability for a service varies widely among users and depends upon the applications utilized and the importance of those applications in the user's business operations. For example, a 300 baud service used for time sharing is normally more sensitive to interruptions than the same service used for administrative data traffic. Similarly, a time-share user may be willing to wait a considerable length of time for a circuit to be repaired but cannot tolerate a 10 second interruption. On the other hand, a stockbroker may easily tolerate a one minute interruption but cannot afford a half hour outage, because the telephone system in this case is an integral part of his business operations.

Previous user surveys, including the one conducted by Western Union, revealed that most users currently use the same network/service for their voice and data communications needs. Furthermore, the same service is being used for several voice and data applications among which are certain applications that could easily tolerate a lower reliability than that of the present service. Most users were unable to assess their required circuit reliability levels by application and even more hesitant about projecting the effect of reliability changes.

As an alternative, open-ended discussions were held with major industry leaders (i.e., "Pacesetters"), industry consultants, and Western Union technical and sales personnel. Based on these discussions, each service

application was analyzed and evaluated for its primary reliability level and its demand forecast (i.e., Net Long Haul Traffic Volume Forecasts) was then segregated into high, medium and low reliability levels.

3.0 METHODOLOGY

From a carrier's point of view, reliability of a system/service is a discretely quantifiable design criterion, but for most users it is a qualitative measure of the service performance. Users (telecommunications managers) normally measure the reliability or quality of a service by the number and frequency of complaints they get from their end users (management and clerical employees). It is difficult for them to define required reliability standards for each of the several applications the service is or will be used for. Furthermore, from the users' point of view, it is the carrier who is responsible for the end-to-end reliability of a service.

The task involved defining the terms high, medium and low reliability levels. Based on outside consultant data and discussions with Western Union technical experts, "High Reliability" was defined as 99.9 through 99.99% availability of a system/service; "Medium Reliability" as 99.0 through 99.9%; and "Low Reliability" as 95.0 through 99.0%. These reliability levels were further defined in terms of outage interval and frequency of occurrence. An assumption of 365 days availability was used as 100% reliability. Therefore, 99.99% reliability/availability means an outage interval of 53 minutes per year and an average frequency of 50 seconds per day. Table VI-1 summarizes the reliability definitions.

Table VI-1 - Summary of Reliability Levels

RELIABILITY CATEGORY	RANGE OF LEVEL %		OUTAGE INTERVAL PER YEAR		EXPECTED FREQUENCY (OUTAGE/DAY)	
	UPPER	LOWER	BEST CASE	WORST CASE	BEST CASE	WORST CASE
HIGH	99.99	99.9	53 Minutes	9 Hours	9 Seconds	1.5 Minutes
MEDIUM	99.9	99.0	9 Hours	3.5 Days	1.5 Minutes	14 Minutes
LOW	99.0	95.0	3.5 Days	18 Days	14 Minutes	1 Hour

Each of the 31 service applications for voice, data and video services was analyzed and evaluated for its "primary reliability level" (High, Medium or Low). A list segregating those applications by their primary reliability classification was prepared (Table VI-2). The demand forecasts of each service application (developed in Task 2.A) was rationalized and appropriately segmented into the three reliability levels.

Table VI-2 - Service Applications by Primary Reliability Level

SERVICE APPLICATIONS	HIGH RELIABILITY	OUTAGE TOLERANT: INTERRUPTION TOLERANT	OUTAGE TOLERANT: INTERRUPTION AND OUTAGE TOLERANT
VOICE			
MTS (PUBLIC)	x		
MTS (BUSINESS)	x		
PRIVATE LINES		x	
RADIO PROGRAM TRANSMISSION	x		
MOBILE RADIO TELEGRAPH		x	
DATA			
DATA TRANSFER			x
BATCH			x
DATA ENTRY (HIGH SPEED)			
DATA ENTRY (LOW SPEED)		x	
REMOTE JOB ENTRY		x	
INQUIRY/RESPONSE	x		
PRIVATE TIMESHARING	x		
COMMERCIAL TIMESHARING	x		
PACKET SWITCHING	x		
ADMINISTRATION		x	
OPERATIONAL FACSIMILE			x
CWP		x	
CONVENIENCE FACSIMILE		x	
MAILBOX SERVICES		x	
TELEX/TWX		x	
MAILGRAM/TELEGRAM		x	
USPS EMSS			x
EFTS/POS INQUIRY/RESPONSE	x		
DATA ENTRY/DATA TRANSFER		x	
SPECIAL PURPOSE FACSIMILE		x	
SECURE VOICE	x		
MONITORING SERVICES	x		
VIDEO			
NETWORK VIDEO	x		
OCCASIONAL VIDEO	x		
CATV DISTRIBUTION	x		
TELECONFERENCING	x		
INTERACTIVE HOME VIDEO		x	

Then, the overall proportions for voice, data and video service demand for High, Medium and Low reliability were calculated for the years 1980, 1990 and 2000 (Table VI-3).

4.0 SIGNIFICANT CONCLUSIONS

From the user's point of view, the acceptable level of reliability is a very subjective and qualitative issue. Most users are unable to define their service reliability requirements by application and tend to employ a high reliability service for both their high and low reliability traffic demand. The results of this task are based on a synthesis of discussions tempered with Western Union's own market experience.

The results lead to the following key conclusions:

- Primarily, voice and video services support high reliability traffic and cannot be easily accommodated by a lower reliability transmission medium.
- A large proportion of data traffic which is currently carried over high reliability, slow speed network systems/services may be diverted to a lower reliability system.
- Telecommunications systems and services are becoming more and more important to users' business operations. Users, concerned about their escalating telecommunication costs, will use lower reliability service to reduce those costs but will normally maintain a considerable portion of their high reliability service. This high reliability service may be maintained to provide a backup for the lower reliability service, in addition to carrying their high reliability service.

TABLE VI-3 - SERVICE DEMAND AS A FUNCTION OF RELIABILITY

(PERCENT OF TOTAL)

	VOICE			DATA			VIDEO		
	1980	1990	2000	1980	1990	2000	1980	1990	2000
RELIABILITY LEVEL									
HIGH	62	66	70	44	42	41	97	86	74
INTERRUPTION TOLERANT	38	34	30	32	31	30	3	11	16
OUTAGE TOLERANT	-	-	-	24	27	29	-	3	10
	100	100	100	100	100	100	100	100	100

TASK 6.B.1 PRICE AS A FUNCTION OF RELIABILITY

1.0 STATEMENT OF WORK

The contractor shall determine and display graphically the demand/price relationship for service reliability. That is, determine what a user is willing to pay for a service as a function of outage time.

2.0 INTRODUCTION

Reliability is a qualitative measure of overall service performance. Service performance, however, is not realistically assessed in light of a service's functional application. Over the years Western Union has conducted personal and mail surveys to measure users' price-reliability relationships statistically. The results have not been conclusive. There are two primary reasons for these inconclusive results:

- Users tend to employ the same service for several applications and very few are able to define their reliability requirements by application.

- The value and perception of service reliability varies widely between users.

When the quality of communications service changes from an established or expected standard, users anticipate a change in the price they pay for the service. A consensus developed from interviews was that users are generally critical about any reduction in reliability and would require significant cost savings to switch to a lesser service. Conversely, if reliability is increased from currently acceptable levels, users would be willing to accept only a slight price increase.

3.0 METHODOLOGY

Today's telecommunications manager is keenly aware of the trade-offs of price versus grade of service. But his decision to select a system or service from given alternatives is more often than not based upon several factors independent of service reliability. These are his relationship to carriers providing other communications services, the reputation of a carrier's pricing policies, the geographical coverage of the service, and the responsiveness of the carrier to new installations and repairs.

Of course, service reliability is one of the major concerns for a telecommunications manager, but, his reliability criteria simply reflect the end users' perception of the new service and the new reliability level. Generally speaking, end users are very critical about any reduction in current service reliability levels, and the only way the telecommunications manager can justify use of the less reliable service is by significantly reducing the corporation's telecommunications costs. The user's ultimate decision would still depend upon whether the new service with a lower reliability level will be used for his high reliability traffic demand or for the demand which can tolerate service interruptions and outages.

Western Union's own experience in the marketplace has shown that any service with a reliability level of 99% or less will not be acceptable to the overwhelming majority of users for their high reliability traffic demand. A service reliability level of less than 95% will not be acceptable for their low reliability/outage tolerant demand. The consensus of opinions, established from open-ended discussions, was that for any perceivable reduction in service reliability from its present level, users would expect at least a 10% to 15% cost savings. Users expectations for price reduction increase exponentially, with further decreases in reliability. At some point, the telecommunications manager will not accept that level of service at any price.

On the other hand, if the reliability of a service is increased from the existing level, users would be willing to accept only a small price increase. The most they would be willing to pay for the highest level of reliability would be in the range of 5% to 15% for their high reliability demand. These ranges are believed to represent the price expectations of two diverse categories of user groups. One is "cost conscious" and is inclined to derive whatever savings are available but is still constrained by a critical level beyond which the service is disqualified. For the second group, the "reliability conscious", any reduction in reliability would have to be matched by significantly greater cost savings. This group would be willing to pay a little more than the cost conscious group for a service with an increased reliability level.

Based on the above user analysis, two user attitude models were constructed displaying the anticipated price change behavior of these two groups for increased and decreased levels of service reliability and also for high reliability and outage tolerant traffic demand (Figures VI-2 and VI-3). The "High Reliability" demand model assumes that for the increasing reliability level case, users currently utilize 99% reliability service and the level is increased ultimately to 100%. However, for the decreasing reliability model, it was assumed that the users currently have 99.99% service reliability for this demand.

The low reliability or outage tolerant demand model assumes that for the increased reliability case, users currently have a 95% service reliability level and that the reliability is increased to 100%. But for decreased reliability it was assumed that the users are currently utilizing a high reliability service (i.e., 99.99%) for their outage tolerant demand and are willing to defer this traffic to a lower reliability level, but not one less than 95%.

PRICE CHANGE AS A FUNCTION OF RELIABILITY

(HIGH RELIABILITY DEMAND)

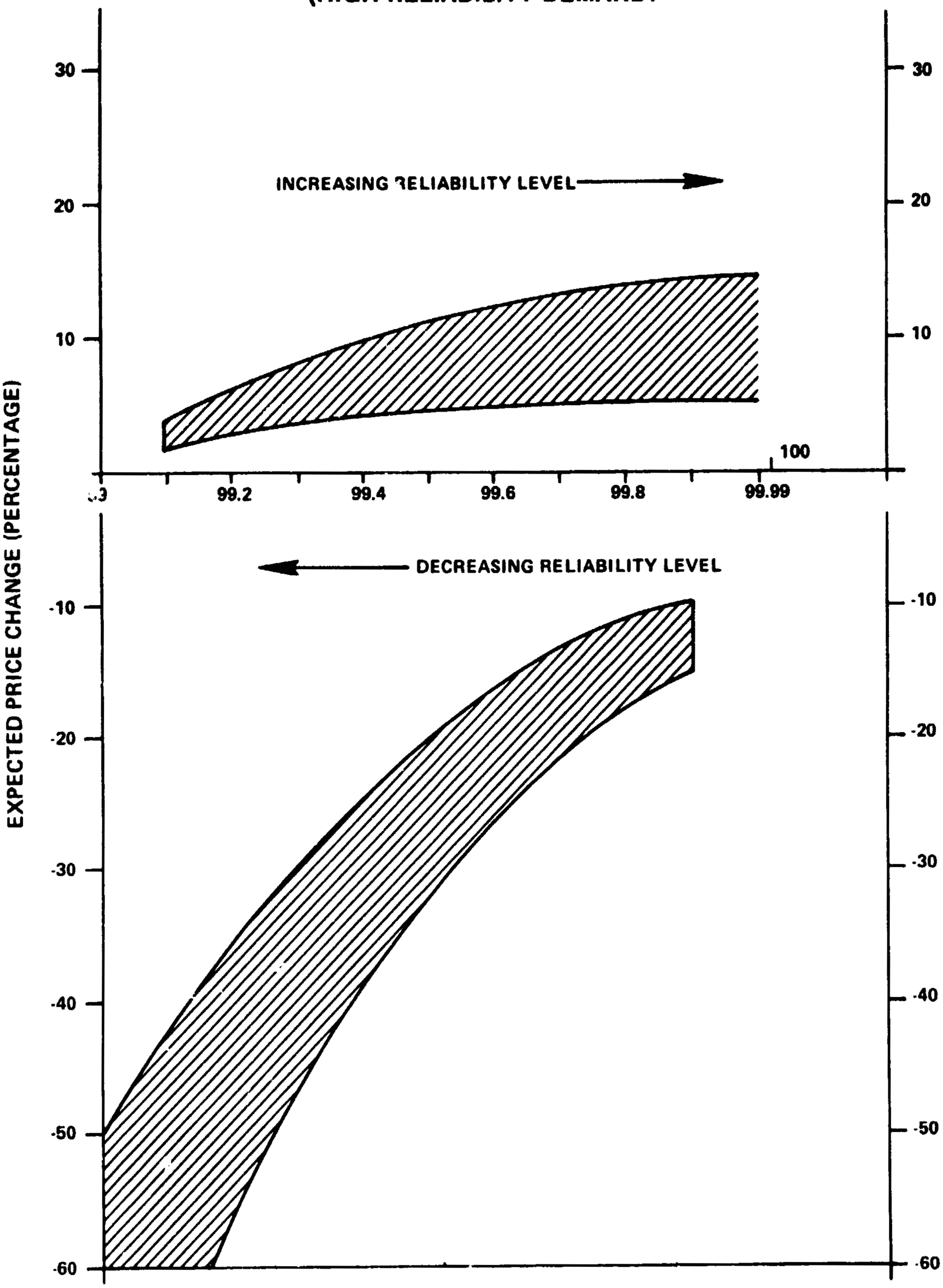


FIGURE VI-2

PRICE VERSUS SERVICE RELIABILITY

(OUTAGE TOLERANT DEMAND)

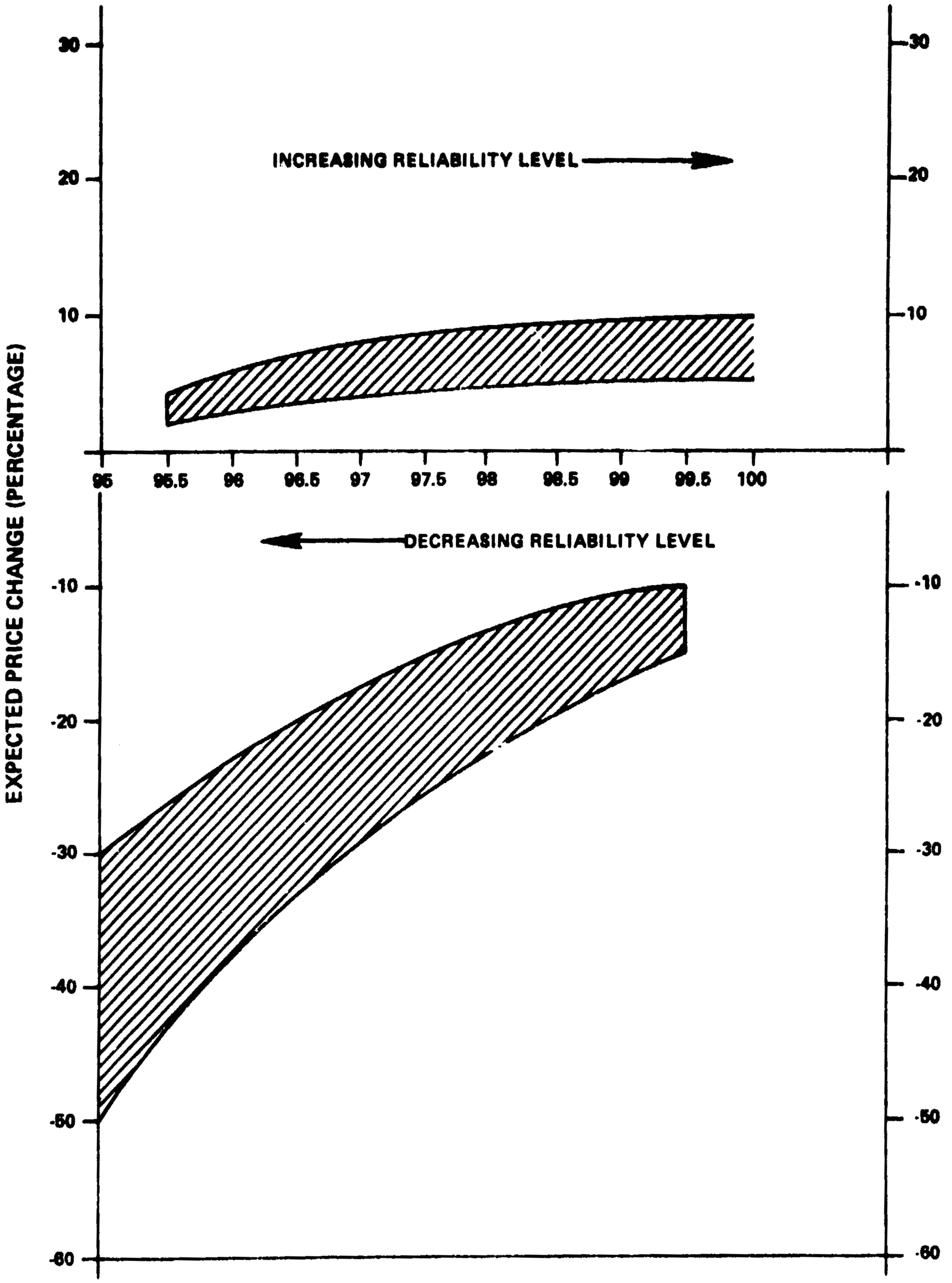


FIGURE VI-3

4.0 CONCLUSIONS

The following key conclusions may be derived from the results:

- Although controlling or reducing corporate telecommunications costs is the primary objective of a telecommunications manager, he is not expected to achieve this goal at the expense of the corporation's operational efficiency.

- In general, users (particularly the end users) are more critical about any reduction in service reliability, but their enhanced perception of a service with increased reliability is only marginal.

- Users would require significant cost savings to switch to a less reliable service. Conversely, if the reliability level is increased from one currently acceptable, the user would be willing to accept only a small price increase.

TASK 6.B.2 PRICE AS A FUNCTION OF NON-REAL TIME DELIVERY

1.0 STATEMENT OF WORK

The contractor shall assess the worth of real time versus non-real time services. Some services presently provided in real time might be satisfactorily delivered in a store and forward mode. The contractor shall identify and list these services, and determine and display what the users are willing to pay for non-real time delivery relative to real time delivery.

2.0 INTRODUCTION

Currently, most telecommunications services operate on a real-time basis, that is, the input and delivery of information takes place at about the same time. Because basic voice or data services are frequently shared among diverse applications, users are left with few choices but to rely upon the same real-time delivery service for both their real-time and non-real time traffic. This practice continues for two reasons: first, it is usually more economical to maximize utilization of a single service, and secondly, alternative non-real time services have not been widely available.

Western Union's experience with certain non-real time delivery message services such as Mailgram indicates that the demand for non-real time (delayed) delivery service is price elastic.

Increasingly, real-time services are being offered at reduced rates for use during off-peak hours such as evenings or weekends. Some data applications, notably batch processing and data transfer, utilize off-peak hours just as much as they utilize the peak hours.

Store-and-forward transmission services, as an alternative to real-time and delayed real-time services, have become increasingly available in recent years. (The delayed facsimile services of Graphnet and Southern Pacific Communications are two examples.) These services allow a user to input data or messages on a real-time basis. But when immediate delivery is not necessary, the information is stored by the carrier for later delivery. Compared with real-time services, the user benefits through increased flexibility and economy for lower priority applications.

Based on the above comments, it was necessary to identify those applications which could be adapted to store-and-forward techniques and for which information delivery could be delayed one hour or more. This list of applications becomes the addressable market for evaluating price as a function of non-real time delivery.

3.0 METHODOLOGY

Each service application categorized as either "High Reliability Demand" or "Outage Tolerant Demand" in Task 6.A was further evaluated for its technical and operational adaptability to store-and-forward techniques. It was determined that almost all current voice and video service applications require high service reliability and hence demand real-time delivery of traffic over the time-frame of the study period. Seven of the 22 data service application are categorized as "High Reliability Demand" and require real-time delivery of information. Only 11 of the remaining 15 data service applications lend themselves to a store-and-forward system and can tolerate service interruptions and outages. However, only a portion of the demand for those applications can be time-deferred. Table VI-4 provides a list of those low-priority type applications.

Table VI-4 - Non-Real Time Service Applications

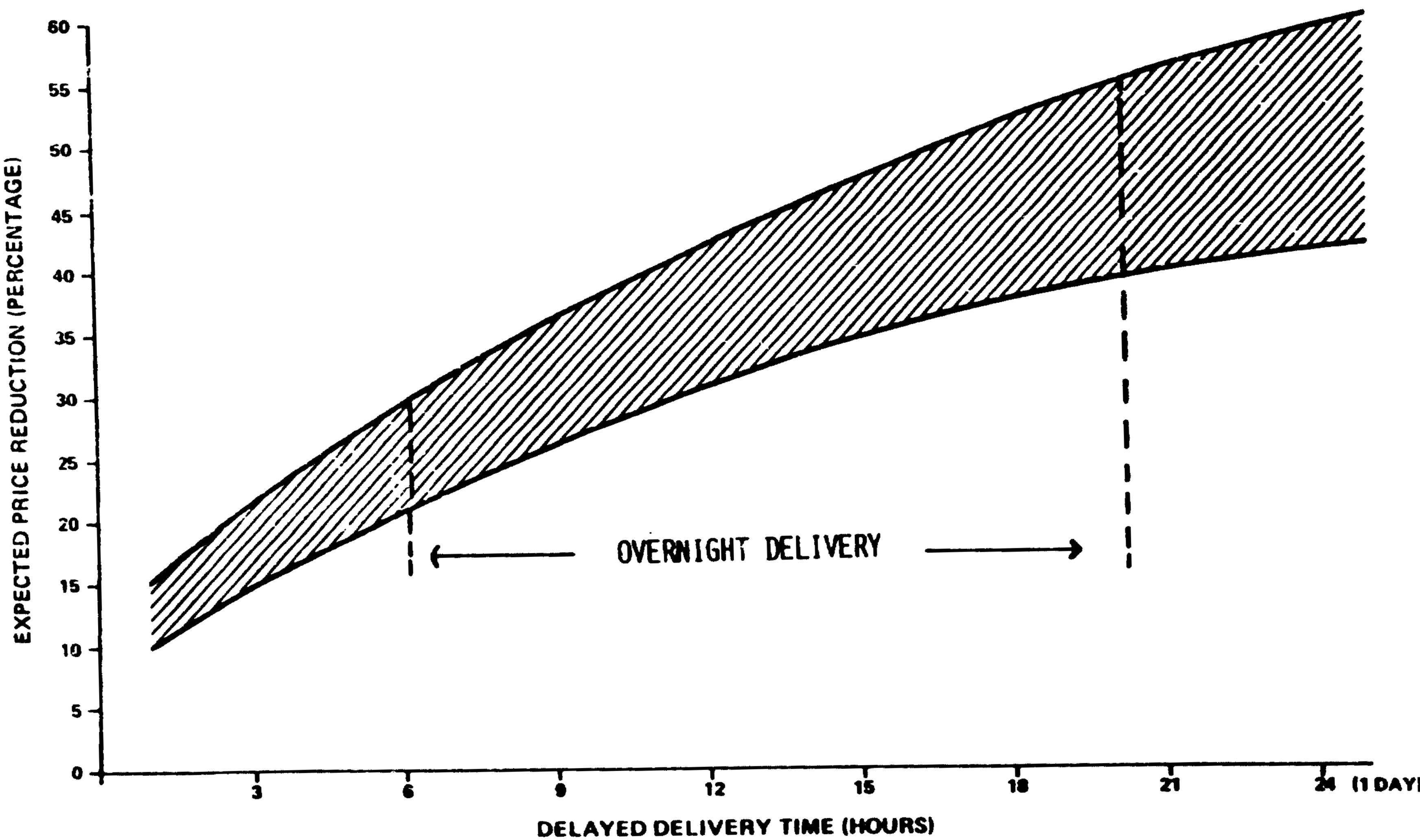
(Adaptable to a Store-and-Forward System)

DATA: SERVICE APPLICATION	PRIMARY RELIABILITY: INTERRUPTION TOLERANT	PRIMARY RELIABILITY: OUTAGE TOLERANT
Data Transfer		x
Batch		x
Remote Job Entry	x	
Administrative	x	
Operational Facsimile		x
CWP	x	
Convenience Facsimile	x	
Mail Box Services	x	
Telex/TWX (via InfoMaster)	x	
Mailgram/Telegram	x	
USPS EMSS		x

VOICE: NONE

VIDEO: NONE

Today, most users employ the same high reliability and real-time service for their low priority and outage tolerant traffic. From end users' point of view, deferring or delaying delivery of some of their communications traffic demand to a later point in time could only be justified by a minimum of 10-15% cost savings and their expectations for price reduction would increase with further delays up to 24 hours. Based on the above analysis, a user attitude model was developed to illustrate the user price expectations for varying times of delivery (Figure VI-4). Once again the ranges for each



PRICE CHANGE AS A FUNCTION OF NON REAL-TIME DELIVERY

(LOW RELIABILITY DEMAND)

FIGURE VI-4

time of delivery represent two extreme user classes, one that is "cost conscious" and inclined to optimize his cost savings from various non-real time deliveries and the "delivery conscious" user that expects greater cost savings for each additional hour of delay.

The ranges shown in Figure VI-4 display a profile of composite attitudes of the above two user classes toward price reductions (cost savings) for each hour of delay in message delivery.

In today's marketplace for electronic delivery systems there are essentially three broad delivery time classifications:

- short - up to one hour
- intermediate - same day
- long - next day

The curve shown in Figure VI-4 does not attempt to identify these plateaus and their price relationships. It should be recognized, however, that from close of business at 6 PM to the start of the next business day at 8 AM a period of "dead time" exists for many firms and a price reduction may be expected.

4.0 SIGNIFICANT CONCLUSIONS

Key conclusions drawn from the task results are:

- Users are reluctant to defer their low priority traffic onto a non-real time delivery service unless this shift brings in at least a 10-15% cost savings.
- Further delays up to 24 hours would require increasingly higher savings, but the rate of expected cost savings would decrease after 8 hours of delay.
- Users would expect a price reduction of 40 to 60% for next day delivery. Office-oriented applications, i.e., convenience facsimile and mailbox services, are the most suitable for non-real time services.
- Currently, voice and video service applications are not adaptable to store-and-forward techniques. In the next 10 years there may be some new applications of these services which could be delivered satisfactorily through such a system.

TASK 6.C 18/30 GHz SERVICE DEMAND FORECAST

1.0 STATEMENT OF WORK

The contractor shall estimate the amount of traffic for which 18/30 GHz systems appear to be an attractive choice in the years 1990 and 2000.

2.0 INTRODUCTION

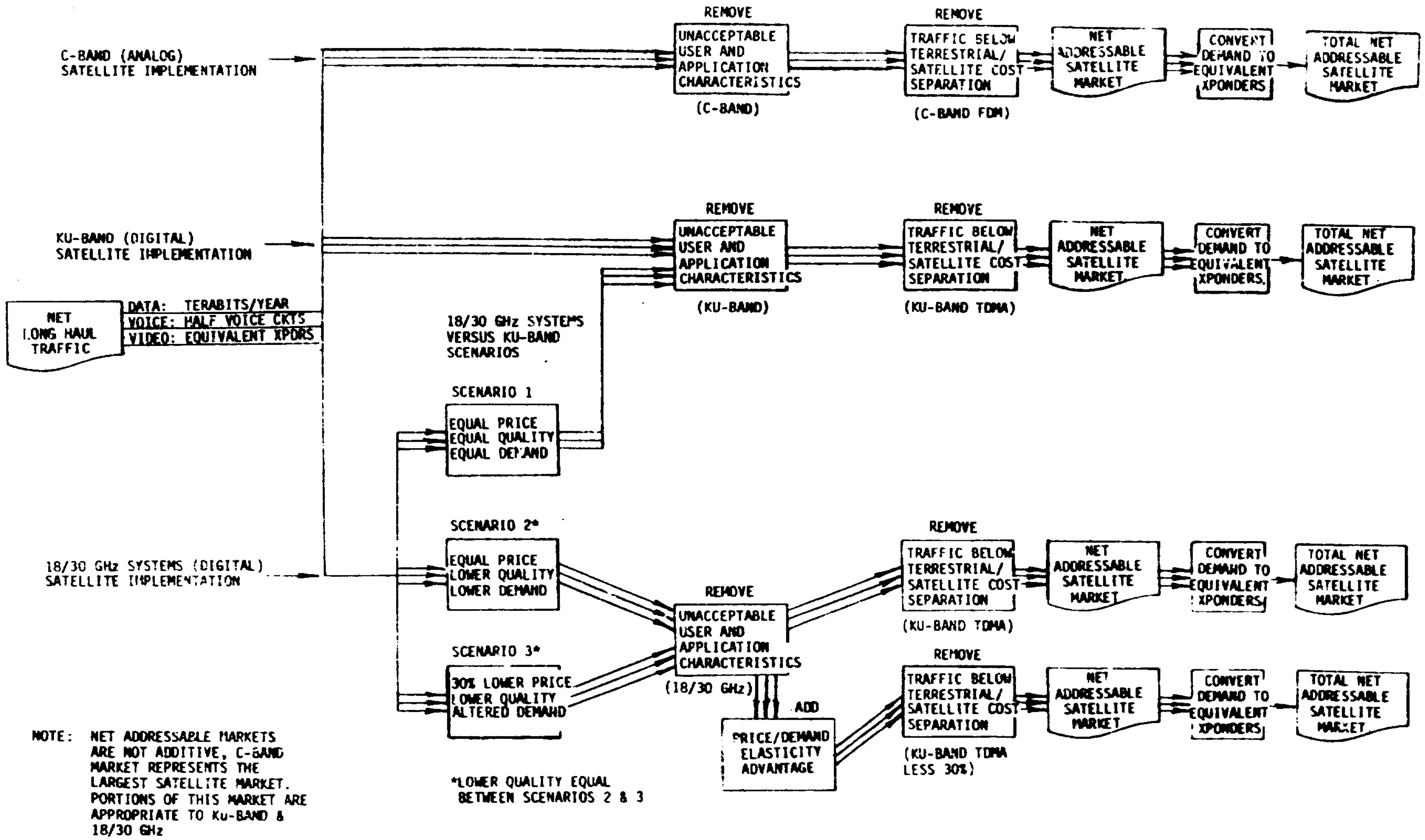
This task represents the culmination of the Market Study effort. The forecasts generated as a part of Task 6.C identify and quantify that portion of total telecommunications traffic which will be suitable for 18/30 GHz satellite systems. Knowledge of the size and makeup of this segment of the market demand is important in that, in the foreseeable future, C and Ku-band satellite capacity could become saturated with expanding traffic requirements.

A number of factors play a part in determining the potential for 18/30 GHz system satellite traffic as distinguished from C and Ku-band systems. Principal among them are operational characteristics such as weather induced service outages, technical considerations such as methods of message distribution and economic realities such as the comparative prices for all service alternatives. The development of technology in support of all forms of satellite and terrestrial transmission will play a significant role in determining the weight given to each factor used in the analysis of 18/30 GHz systems market demand.

The output of Task 6.C is the forecast of the net addressable (18/30 GHz system) satellite market for each of the three service categories: voice, video and data. To give greater perspective to the results, two additional elements were added to the basic forecasts. First, multiple scenarios were developed which varied the price and quality of service associated with 18/30 GHz systems. Second, the forecasts for each service category, which were presented in the unit of measurement appropriate to the category, were converted to a common unit of measurement, megabits per second. In this way, insight was gained with regard to the impact of different controlling factors and the proportional contribution of each service category could easily be ascertained.

3.0 METHODOLOGY

Figure VI-5 is a flow diagram of the logic used to identify and quantify that portion of the net long haul traffic addressable by each of the three forms of satellite transmission. The forecasts for C-band and Ku-band market demand were discussed in the analysis conducted as a part of subtask 5.C. Task 6.C deals with the branches of the Figure which involve 18/30 GHz systems satellite implementation.



FLOW DIAGRAM: NET LONG HAUL TRAFFIC TO NET ADDRESSABLE SATELLITE MARKET 18/30 GHZ SCENARIOS

FIGURE VI - 5

Three scenarios were devised to provide insight into the variations of service quality and price most likely to be encountered in a potential 18/30 GHz system. (The scenarios were required because firm system cost and service quality parameters were not available from the systems contractor at a time consistent with the schedule proposed for the service contractors. However, a great deal of useful information on 18/30 GHz system design and component cost was made available by the systems contractors which gave support to the concept of a limited number of market scenarios.)

Scenario 1 identified an 18/30 GHz system which would equal the service quality of the Ku-band systems currently being readied for launch particularly in the matter of system availability. This scenario also projects a service price equivalent to that proposed for Ku-band services in subtask 5.A, Service Cost Comparisons. With these two major factors made equivalent, the method of long haul transmission used should be transparent to the user and should not affect market demand. This equivalency is reflected on the flow diagram by combining the logic paths for Ku-band and 18/30 GHz/Scenario 1 systems.

Scenario 2 identified an 18/30 GHz system which would offer a service quality significantly reduced from that available on the Ku-band system. The price asked for this service would be equivalent to that asked for Ku-band service. Scenario 2 market demand represents the theoretical amount of traffic which can accept this lesser service quality without regard to the availability of a Ku-band alternative. Under actual market conditions, no traffic would appear on such a system until Ku-band capacity was saturated making the 18/30 GHz/Scenario 2 system strictly a repository for the overflow from Ku-band traffic.

Scenario 3 identified an 18/30 GHz system which would offer the lesser service quality associated with Scenario 2 but with a price inducement of 30 percent. The price advantage would increase the market demand associated with Scenario 2 in two ways. There is a price/demand elasticity factor generated by the reduced price. And the terrestrial price/distance crossovers would be significantly affected. The demand associated with Scenario 3 can be expected to significantly exceed that associated with Scenario 2.

In the development of the telecommunications forecasts for all steps of the study to this point, a range of values has always been developed: minimum, maximum and expected case with only the expected case being presented. This range is also included in the forecasts for Scenarios 2 and 3 but Scenario 2 should be considered as the principal exposition of 18/30 GHz market demand and Scenario 3 as a subordinate case offered as an analytical tool.

A fourth scenario might have been presented which would have offered service quality equivalent to Ku-band systems but at a higher price. This option was discarded as offering very little to the study. The price/demand elasticity associated with a significant increase in price would cause a precipitous decrease in demand below that reported for Scenario 2.

The methodology used to quantify the net addressable 18/30 GHz system satellite market requires removal of unacceptable user and application characteristics. As the service quality established for Scenarios 2 and 3 is equal and lower than that established for Scenario 1 and Ku-band services, each of the 31 applications of the three service categories was reassessed to determine its acceptability factor for 18/30 GHz system implementation. The principal element of the reduced service expectation concerns the outage tolerance of each application - particularly those with a nominal "high reliability" requirement as defined in subtask 6.A.

Each appropriate usage and technical characteristic for each service application was revisited and requantified in accordance with the lower service quality associated with Scenarios 2 and 3. Composite qualifying factors were computed for various years over the 1978-2000 time span and applied to the net long haul market demand by computer modeling techniques.

The final step in the calculation of the net addressable 18/30 GHz system satellite market was to impose a cost/distance separation in demand by removing all traffic more economically implemented on terrestrial routes. These separations were determined by comparing terrestrial and K-band TDMA end-to-end costs as analyzed in the parametric cost model (subtask 5.A.) In all satellite cost/distance separations, a 20% cost penalty was imposed on the satellite routes as a necessary inducement to persuade traffic to move from conventional terrestrial implementation to less familiar satellite facilities. This pricing inducement was entirely independent of any usage or technical consideration.

By the definition of Scenario 2, the cost/distance separation is identical to that imposed in the determination of addressable Ku-band demand. Scenario 3 is defined as having a 30% price advantage over Scenarios 1 and 2. The increased demand generated by this advantage is a function of price/demand elasticity and the qualification of additional routes as a result of an improved cost/distance relationship.

The price/demand elasticity was analyzed and quantified in subtask 2.E. The net increase in demand associated with a 30% price advantage was indicated as 7.5%. The flow diagram shows the positioning of this increase immediately after the removal of the unacceptable user and application characteristics.

Application of cost/distance information from the parametric cost model and route market values from the Market Distribution Model allows automatic calculation of changes in demand as a result of variations in service costs. The 30% price advantage of Scenario 3 results in an improvement in the market value of economically acceptable routes of more than 60% over Scenarios 1 and 2. (The actual improvement is a function of both service application and year of comparison.) The consolidated improvement of both demand elasticity and route penetration averages approximately 70%.

At this point in the methodology, the net addressable 18/30 GHz satellite market demands have been calculated in terms of the specific units of measurement appropriate to each service category (half voice circuits,

wideband channels and terabits per year). It was useful in the analysis to convert these demands to megabits per second and to equate this peak network requirement to equivalent transponders. The method used has been described in considerable detail in subtask 5.C. By using a common unit of measurement for all service categories, the relative contribution to total demand for each category can be measured more easily.

4.0 PRESENTATION OF RESULTS: VOICE SERVICES

Table VI-5 shows the net addressable satellite market demand for the three 18/30 GHz system scenarios for the years 1990 and 2000. The percentage distribution of market demand, expressed in thousands of half voice circuits, among the five voice service category applications is also calculated. A more detailed summary of voice category 18/30 GHz net addressable market demand was prepared. Figure VI-6 presents the Scenario 2 market shares of the three surviving applications in a "pie chart" arrangement in which the areas of the "pies" are representative of their relative demand in 1990 and 2000. ("Other" refers to the Mobile Radio Telephone application.)

The units of measurement for Figure VI-6 are equivalent (50 Mbps) transponders. Each digitized half voice circuit is equated to a data rate of 32 Kbps. As an equivalent transponder provides a net usable data rate (channel isolation requirements included) of 50 Mbps, approximately 1560 half voice circuits may be accommodated on each transponder. This conversion factor permits direct comparison of voice service category demand with the video and data service categories when all are quoted in terms of equal equivalent transponders.

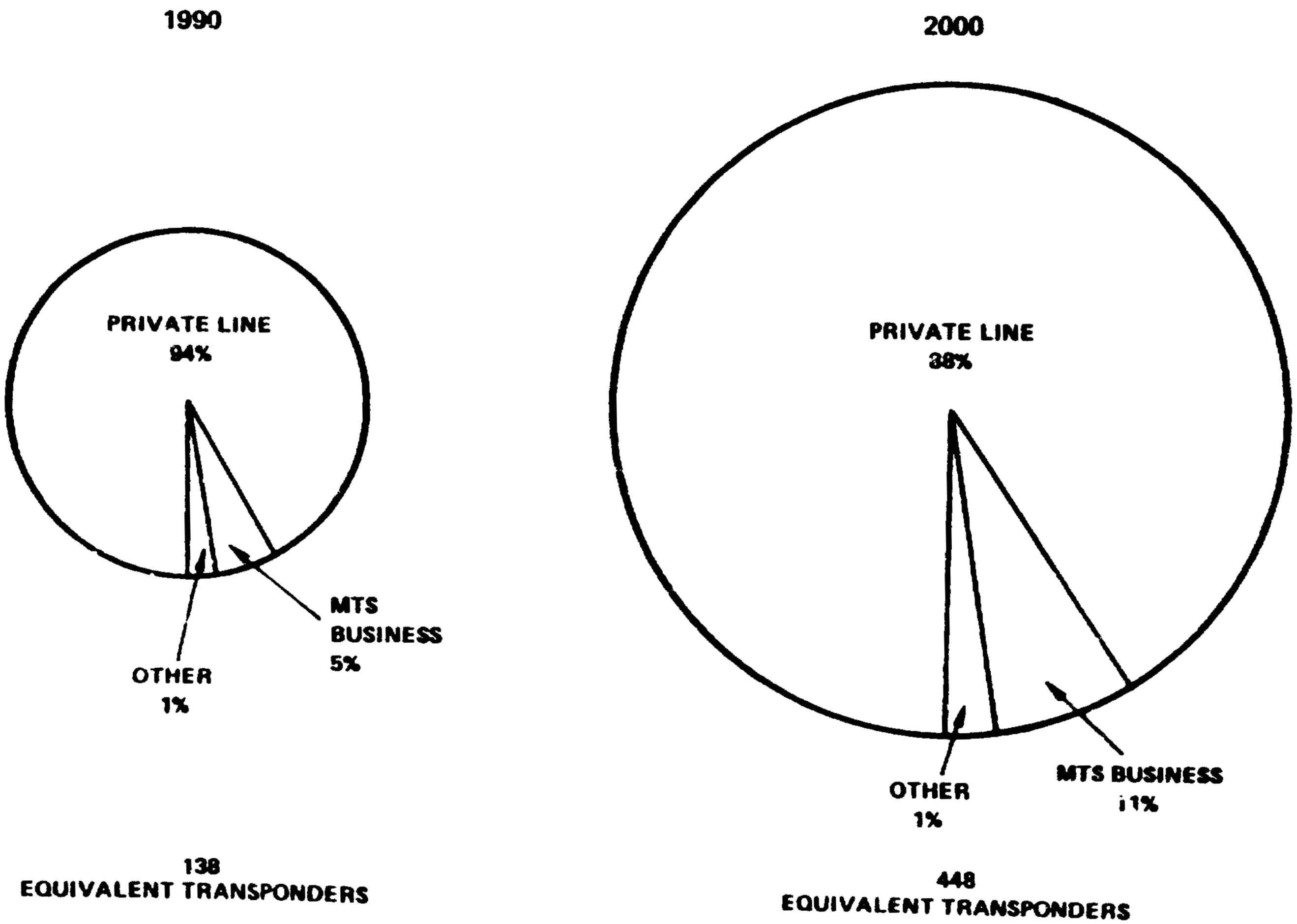
Table VI-5 and Figure VI-6 also show the domination of Private Line over other voice applications when suitability for 18/30 GHz systems is considered. This reflects user attitudes toward increased service outages associated with lower quality services such as may be expected on 18/30 GHz systems. With full period Private Line facilities, often used for intracompany traffic, users exhibit greater tolerance toward occasional outages when weighed against other benefits inherent in dedicated facilities. Composite factors used in quantifying each voice application for unacceptable usage and technical characteristics for the 1978-2000 period were developed.

Users of MTS show substantially less tolerance toward lower quality service than those using Private line facilities. Table VI-5 also shows that MTS (Public) users will be unwilling to accept 18/30 GHz service at the Scenario 2 service quality level. A very small proportion of MTS (Business) users show a willingness to tolerate the Scenario 2 quality. This sensitivity in user attitudes is shown more clearly in Table VI-6 which displays the year 2000 distribution of the major voice category applications in each of the several markets used in developing the forecasts for this study. Starting with the net long haul market, each subsequent transmission system shows a composite decrease in service quality or adaptability. Those applications which can function at decreased quality levels, particularly with respect to reduced availability, show the least erosion in demand and an increasing share of the

Table VI-5

Net Addressable Satellite Market
18/30 GHz Systems - Voice Category - Expected Case Summary
Years 1990 and 2000 - Thousands of Half Voice Circuits (KHVC)

		Scenario 1 (Ku-Band)		Scenario 2		Scenario 3	
	Application	KHVC	Percent	KHVC	Percent	KHVC	Percent
1990	Private Line (incl. TELPAK)	298	80.0	202	94.0	369	94.0
	MTS (Public - incl. coin)	32	8.4	0	-	0	-
	MTS (Business - incl. WATS)	40	10.7	11	5.2	20	5.2
	Radio Program Transmission	neg	0.1	0	-	0	-
	Mobile Radio Telephone	3	0.8	2	0.8	3	0.8
	Total, 1990	372	100.0	214	100.0	392	100.0
2000	Private Line (incl. TELPAK)	824	72.7	618	88.6	1073	88.5
	MTS (Public - incl. coin)	115	10.2	0	-	0	-
	MTS (Business - incl. WATS)	186	16.4	75	10.7	129	10.7
	Radio Program Transmission	neg	neg	0	-	0	-
	Mobile Radio Telephone	8	0.7	5	0.7	9	0.8
	Total, 2000	1133	100.0	697	100.0	1211	100.0



NET ADDRESSABLE 18/30 GHz SATELLITE MARKET
VOICE CATEGORY APPLICATIONS
SCENARIO 2
FIGURE VI-6

particular market. In this way, Private Line increases from a 34% share of the net long haul market to a 89% share of the Scenario 2 18/30 GHz system market. This increase in market share is in spite of an 87% erosion in absolute demand from the net long haul base.

Table VI-6 Distribution of Voice Category Applications By Market
Year 2000 - Expected Case
(In Thousands)

	Private Line		MTS (Public)		MTS (Business)	
Market	Half Ckts.	Percent	Half Ckts.	Percent	Half Ckts.	Percent
Net Long Haul	4677	34.0	3920	28.5	5078	36.9
C-Band	1776	61.1	418	14.4	676	23.3
Ku-Band & 18/30 GHz, Scenario 1	824	72.7	115	10.2	186	16.4
18/30 GHz, Scenario 2	618	88.6	0	--	75	10.7

Note: Mobile Radio Telephone and Radio Program Transmission voice applications represent less than 1 percent of total demand in these markets and are deleted for clarity.

Mobile Radio Telephone, a relatively insignificant constituent of the voice service category, shows considerable resistance to lower service quality. The analysis of this application concluded that the low quality of current service has reduced user expectations to the extent that 18/30 GHz satellite trunking of such long distance traffic would be transparent to users for all practical purposes.

The composite average annual growth rates for Scenarios 1, 2 and 3 are 11.8%, 12.5% and 11.9% respectively, for the ten year period between 1990 and the year 2000.

5.0 PRESENTATION OF RESULTS: VIDEO SERVICES

Table VI-7 shows the video net addressable satellite market for the three 18/30 GHz system scenarios for the years 1990 and 2000. The percentage distribution of each market among the five video service category applications is also calculated. The distribution is shown as a function of demand expressed in equivalent (50 Mbps) transponders. The conversion from wideband channels to equivalent transponders was required for the Teleconferencing and Interactive Home Video applications, while the channels for the other video category applications were equated to a full transponder. This compensates for certain fundamental

Table VI-7

Net Addressable Satellite Market
18/30 GHz Systems - Video Category - Expected Case Summary
Years 1990 and 2000 - Equivalent (50 Mbps) Transponders

		Scenario 1 (Ku-Band)		Scenario 2		Scenario 3	
	Application	Transponders	Percent	Transponders	Percent	Transponders	Percent
1990	Network Video	1.7	2.4	0.2	0.8	0.2	0.7
	Occasional Video	9.9	14.2	0.9	3.6	1.0	3.7
	CATV Distribution	23.2	33.2	6.1	24.4	6.6	24.5
	Teleconferencing	35.0	50.1	17.8	71.2	19.1	71.0
	Interactive Home Video	NA	-	NA	-	NA	-
	Total, 1990	69.8	99.9	25.0	100.0	26.9	99.9
2000	Network Video	3.3	2.2	0.7	1.0	0.8	1.1
	Occasional Video	12.2	8.3	1.6	2.3	1.7	2.3
	CATV Distribution	30.0	20.4	9.6	13.9	10.3	13.8
	Teleconferencing	96.1	65.4	53.0	76.5	56.9	76.5
	Interactive Home Video	5.4	3.7	4.4	6.3	4.7	6.3
	Total, 2000	147.0	100.0	69.3	100.0	74.4	100.0

differences in transmission style - principally in the requirement for multipoint distribution of signals. A more detailed summary of video category 18/30 GHz net addressable market demand, expressed in both wideband channels and equivalent transponders, was prepared.

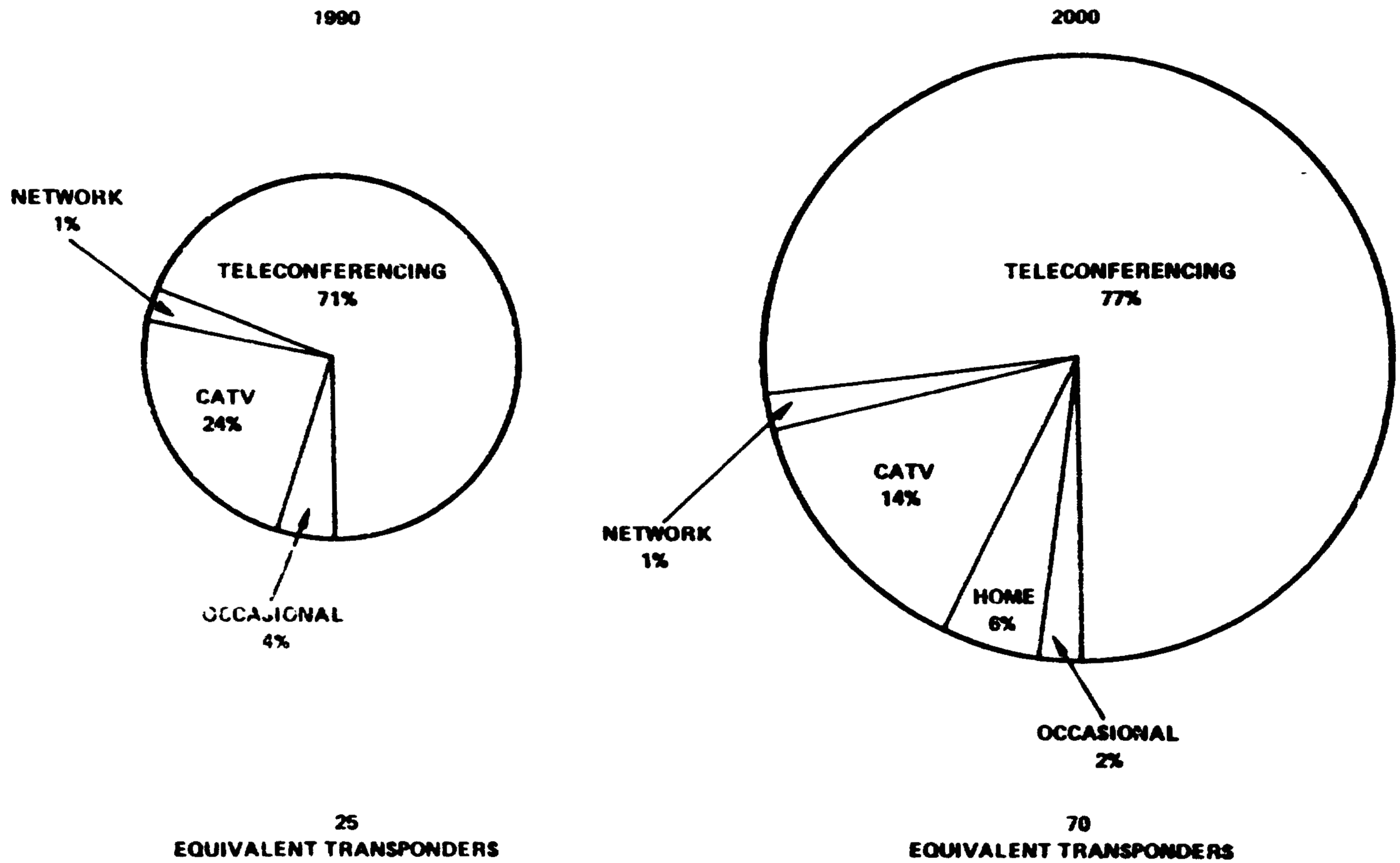
Figure VI-7 presents the Scenario 2 application market shares in a "pie chart" arrangement in which the areas are representative of their relative demand in 1990 and 2000. The percentage distribution is based on demand in equivalent transponders.

The Table and Figure illustrate the dominance of the Teleconferencing application in the 18/30 GHz system addressable market. All video applications suffer considerable erosion in demand (53% in the year 2000) between Scenario 1 (Ku-band) and Scenario 2 due to the general decrease in service quality - specifically service availability. Teleconferencing and Interactive Home Video appear to be the applications most tolerant of these deficiencies and the market shares associated with them show substantial improvement.

Very small proportions of the Network, Occasional and CATV Distribution applications are suitable for 18/30 GHz system implementation for two specific reasons. First, they generally require broadcast type program distribution associated with the C-band system model used in this study (see subtask 5.C for analysis) and, second, these applications require a higher level of service quality in which transmission outages are minimized. Table VI-8 shows the year 2000 distribution of applications in each of several markets which have a descending order of service quality and adaptability. The Network Video application decreases in market share from 21% in the net long haul market to 1% in the Scenario 2 market. Occasional Video and CATV Distribution show similar, though less dramatic, declines in market share. The erosion in transponder requirements for these applications is even greater because of the 75% decline in total video service category demand between the net long haul demand (279 transponders) and Scenario 2 demand (70 transponders).

Table VI-8 Distribution of Video Category Applications by Market
Year 2000 - Expected Case
(Percentage Proportions Developed From
Equivalent 50 Mbps Transponders)

Market	Network	Occasional	CATV	Teleconferencing	Home
Net Long Haul	21%	14%	32%	32%	1%
C-Band	13%	16%	23%	46%	2%
Ku-Band & 18/30 GHz, Scenario 1	2%	8%	20%	65%	5%
18/30 GHz, Scenario 2	1%	2%	14%	77%	6%



NET ADDRESSABLE 18/30 GHz SATELLITE MARKET
VIDEO CATEGORY APPLICATIONS
SCENARIO 2

FIGURE VI-7

The increase in Scenario 3 traffic over Scenario 2 is limited to the 7.5% price/demand elasticity associated with the 30% price advantage enjoyed by Scenario 3. The concept of a cost/distance separation of video category traffic is inapplicable due to the nature of the service and the parameters established for each application definition as described previously (in subtask 2.A).

The composite average annual growth rates for Scenarios 1, 2 and 3 are 7.7%, 10.8% and 10.8% respectively, for the ten year period between 1990 and the year 2000.

The Teleconferencing application exhibits the greatest share of video service category demand on 18/30 GHz systems and deserves some further definition. Table VI-9 shows the demand, expressed in 50 Mbps equivalent transponders, associated with the Full, Limited and Slow Motion segments of the teleconferencing application for each of the three 18/30 GHz system scenarios for the years 1990 and 2000.

Table VI-9 Net Addressable Satellite Market - Teleconferencing Application
18/30 GHz Systems - Video Category - Expected Case
Equivalent (50 Mbps) Transponders

Teleconferencing Application Segment	Scenario 1 (Ku-Band)	Scenario 2	Scenario 3
Year 1990			
Full Motion	23.3	9.8	10.5
Limited Motion	7.0	4.8	5.2
Slow Motion	4.7	3.2	3.4
Total, 1990	35.0	17.8	19.1
Year 2000			
Full Motion	62.4	29.4	31.5
Limited Motion	20.4	14.3	15.4
Slow Motion	13.3	9.3	10.0
Total, 2000	96.1	53.0	56.9

Each equivalent transponder devoted to Full Motion teleconferencing carries 3 1/3 full period video channels, each currently rated at 22 Mbps (with some compression in bandwidth expected by 1990). Each equivalent transponder assigned to Limited Motion teleconferencing carries a combination of 33 channels of 1.5, 3.1 and 6.3 Mbps bandwidth. For Slow Motion teleconferencing, 165 channels of 56 Kbps bandwidth are carried. Converting the demand in equivalent transponders to specific full period teleconferencing channels, the following totals (Table VI-10) are generated:

Table VI-10 Full Period Teleconferencing Channels

18/30 GHz System	1990	2000
Scenario 1 (Ku-Band)	1084	3076
Scenario 2	719	2105
Scenario 3	768	2263

As these full period channels are expected to be shared by users, both public and intraorganizational, certain scheduling problems can be expected to arise which will limit their potential usage. Experience has shown that in the sale of similar wideband services on an "occasional" basis, approximately 1500 hours of revenue usage can be accommodated by each full period channel dedicated to specific use. Using this activity as a benchmark, year 2000 Teleconferencing activity would range from 3.2 million channel-hours of connection time for Scenario 2 to 4.6 million channel-hours for Scenario 1 (Ku-band).

6.0 PRESENTATION OF RESULTS: DATA SERVICES

The total market demand, expressed in terabits per year, for each step of the methodology previously described, is shown in Tables VI-11 and VI-12 for the years 1990 and 2000. The percentage change in demand associated with each step is also shown so that the relative impact of the process can be seen clearly. All three 18/30 GHz system scenarios are shown for comparison. (Scenario 1 demand is identical to that shown for Ku-band in subtask 5.C and is included here for comparative purposes.)

Among the conclusions which can be drawn from these tables is that, in the data service category, price plays a more dramatic role in restricting or expanding market demand than do usage and technical characteristics. The

Table VI-11 Development of Net Addressable Satellite Market
18/30 GHz System - 1990
Data Category - Expected Case Summary (Terabits)

	Scenario 1		Scenario 2		Scenario 3	
	Terabits	Percent*	Terabits	Percent*	Terabits	Percent*
Net Long Haul Traffic	6957		6957		6957	
Balance after removal of demand having unacceptable characteristics	5504	-20.9	4656	-33.1	4656	-33.1
Balance after addition associated with 30% price/demand elasticity	-		-		5006	+ 7.5
Net Addressable Market (balance after removal of demand below terrestrial/satellite cost separation)	2045	-62.8	1731	-62.8	3208	-35.9
Net Addressable Market as percent of Net Long Haul	29.4%		24.9%		46.1%	

*Percent change from previous step.

Table VI-12 Development of Net Addressable Satellite Market
18/30 GHz System - 2000
Data Category - Expected Case Summary (Terabits)

	Scenario 1		Scenario 2		Scenario 3	
	Terabits	Percent*	Terabits	Percent*	Terabits	Percent*
Net Long Haul Traffic	27553		27553		27553	
Balance after removal or demand having unacceptable characteristics	22316	-19.0	18825	-31.7	18825	-31.7
Balance after addition associated with 30% price/demand elasticity	-		-		20237	+ 7.5
Net Addressable Market (balance after removal of demand below terrestrial/satellite cost separation)	8980	-59.8	7575	-59.8	13708	-32.3
Net Addressable Market as percent of Net Long Haul	32.6		27.5		49.8	

*Percent change from previous step.

advantage of 30% in price, increases demand for equal quality service (Scenario 3 versus Scenario 2) 85% in 1990 and 81% in the year 2000 and increases demand over a superior service (Scenario 3 versus Scenario 1) by 57% and 53% for the years 1990 and 2000, respectively. This suggests that many of the more attractive routes fall near the nominal terrestrial/satellite cost crossover mileages and that a favorable movement in the crossovers will bring considerable additional traffic into the satellite market.

Another conclusion developed in Tables VI-11 and VI-12 indicates that data applications are fairly tolerant of the lower service expectations quantified in Scenarios 2 and 3. The decrease in service availability was set significantly below that postulated for Scenario 1 and the Ku-band. Interactive data applications may find this degradation very difficult to accommodate - but many other data applications can accommodate non-real time transmission and are adaptable to limited service outages. The composite factors used in quantifying each data application for unacceptable usage and technical characteristics for the 1978-2000 period were prepared. The factors which quantify the proportional market demand associated with the various terrestrial/satellite cost crossover mileages for each data application have been developed previously.

Tables VI-13 and VI-14 show the data service category net addressable satellite market demand for 18/30 GHz system scenarios 2 and 3, expressed in terabits, for the years 1990 and 2000. The similar information for Scenario 1, which is equal to the Ku-band market demand, is in subtask 5.C. The 21 data applications have been consolidated into four general groupings, two of which have been further subdivided. The percentage distribution among these groupings and subdivisions is also shown. More detailed summaries of the net addressable 18/30 GHz satellite market demand forecasts for the data service category, expressed in both terabits per year and megabits per second, were developed.

Among the various insights that can be gained from net addressable market demands for the three scenarios are the following:

- Scenario 2 market demand increases approximately 4 1/3 times between the years 1990 and 2000. This represents an AAGR of 15.9%.

- The High Speed/Wideband applications of the Data Transmission grouping increase their proportion of total data service category demand in the year 2000 from 48% in Scenario 1 to 55% in Scenario 3. This reflects the vast amounts of data which can be transferred on wideband facilities and its adaptability to lower quality satellite service.

Table VI-13 Net Addressable Satellite Market
18/30 GHz - Scenario 2
Data Category - Expected Case Summary (Terabits)

	1990		2000	
	Terabits	Percent	Terabits	Percent
Data Transmission Applications (8)				
High Speed/Wideband	577	33	3974	53
Low Speed/Medium Speed	127	7	404	5
Interactive Transmission	143	8	695	9
Packet Switching	10	1	171	2
Subtotal, Transmission	857	49	5244	69
Electronic Mail Applications (8)				
Restricted Access Networks	121	7	827	11
Open Access Networks	641	37	789	10
Subtotal, EM	762	44	1616	21
EFTS/POS Applications (2)	28	2	277	4
Miscellaneous Applications (93)	84	5	438	6
Total, All Applications (21)	1731	100	7575	100

Table VI-14 Net Addressable Satellite Market

18/30 GHz - Scenario 3

Data Category - Expected Case Summary (Terabits)

	1990				2000			
	Terabits		Percent		Terabits		Percent	
Data Transmission Applications (8)								
High Speed/Wideband	1308		41		7555		55	
Low Speed/Medium Speed	264		8		802		6	
Interactive Transmission	220		7		1149		9	
Packet Switching	14		0		301		2	
Subtotal, Transmission		1806		56		9807		72
Electronic Mail Applications (8)								
Restricted Access Networks	268		8		1633		12	
Open Access Networks	943		30		1162		8	
Subtotal, EM		1211		38		2795		20
EFTS/POS Applications (2)		58		2		448		3
Miscellaneous Applications (3)		134		4		659		5
Total, All Applications (21)		3208		100		13708		100

- Growth of High Speed/Wideband applications demand share is the greatest of any item shown. In Scenario 2 the share grows from 33% to 53% in the ten year period. This growth is attributable both to the migration of transmission to higher data rates and the expansion of demand associated with the increased availability of wideband facilities.

- The Open Access Networks applications of the Electronic Mail grouping shows the greatest drop in market share, decreasing from 37% to 10% in Scenario 2 between 1990 and 2000. This is a reaction of the rapid growth experienced in the previous decade when a single application, USPS EMSS, becomes fully implemented. This application (or a comparable equivalent) will rise from a zero position to become one of the largest applications in 1990. As a mature service, its growth will be at a very low rate for the following decade - paralleling first class mail. Despite the radically decreased market share, Open Access Networks show growth from 641 terabits in 1990 to 789 in 2000.

Tables VI-15 and VI-16 show the data service category net addressable satellite market demand for the three 18/30 GHz system scenarios, expressed in megabits per second, for the years 1990 and 2000. The average annual growth rate for the category in Scenario 2 between 1990 and 2000 was 18.1%. This represents a slightly steeper rate than that indicated for the demand expressed in terabits (15.9%). The difference reflects a greater growth among applications which are peak hour oriented over those which are off-peak oriented.

Figure VI-8 presents the market shares of the four data service category application groupings in a "pie chart" arrangement based on the equivalent (50 Mbps) transponder network requirement for Scenario 2. The areas are representative of the relative demand for 1900 and 2000. A comparison of the distribution of demand in the year 2000 for the net addressable market and the net long haul traffic shows the following similarities (Table VI-17).

Table VI-17 Comparative Distribution of Data Service Category Demand Year 2000

Application Grouping	Scenario 2	Net Long Haul Traffic
Data Transmission	66%	74%
Electronic Mail	19	17
EFTS/POS	4	4
Miscellaneous	11	5

Most of the changes in distribution are a result of the ability of certain applications to qualify for satellite implementation - rather than in the quality of that satellite service.

Table VI-15

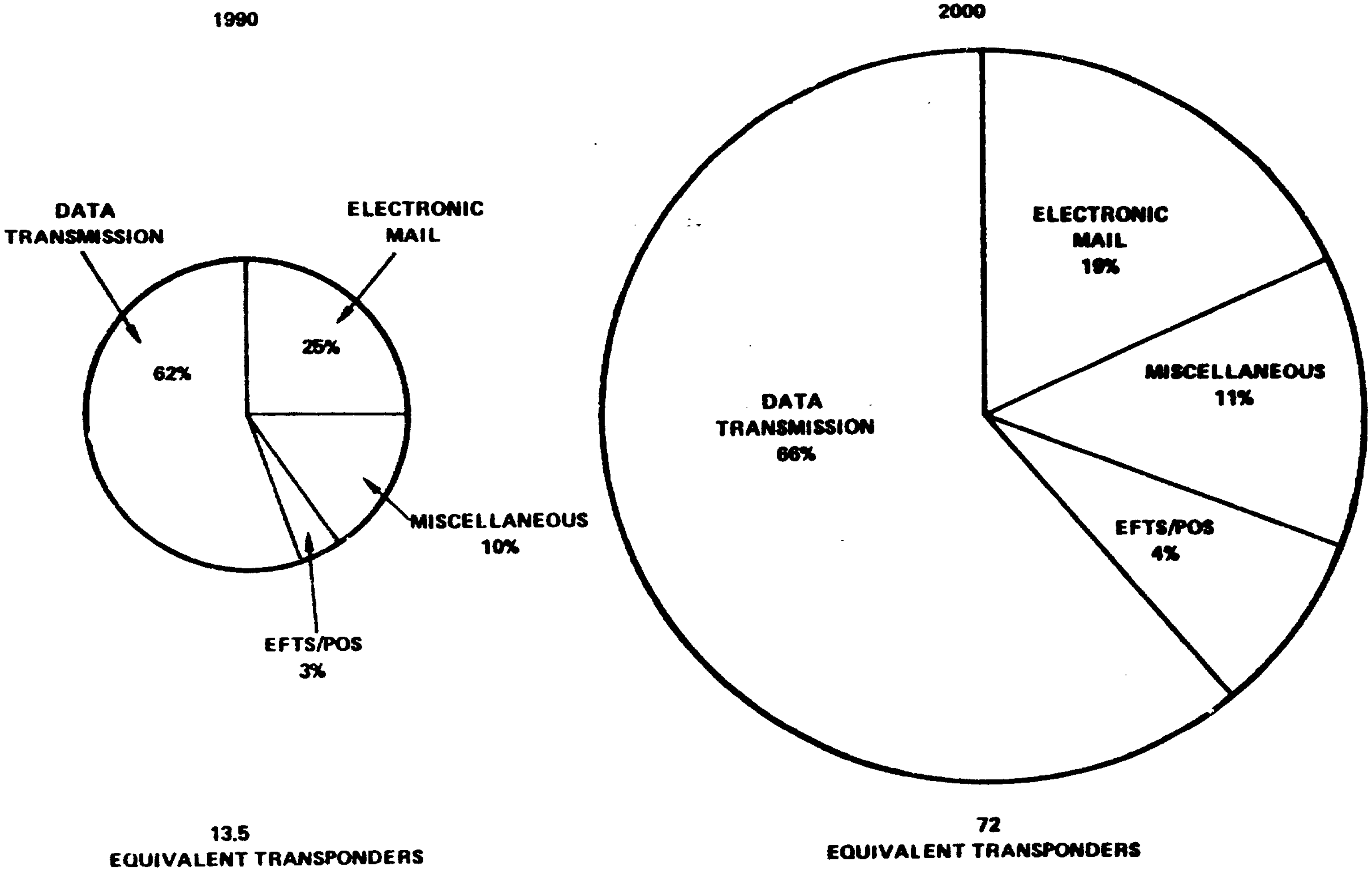
Net Addressable Satellite Market
18/30 GHz System - 1990
Data Category - Expected Case Summary (Mbps)

	Scenario 1		Scenario 2		Scenario 3	
	Mbps	Percent	Mbps	Percent	Mbps	Percent
Data Transmission Applications (2)	619	67	421	62	880	66
Electronic Mail Applications (8)	178	19	167	25	320	24
EFTS/POS Applications (2)	44	5	19	3	29	2
Miscellaneous Applications (3)	79	9	70	10	107	8
Total, All Applications (21)	920	100	677	100	1336	100

Table VI-16

Net Addressable Satellite Market
18/30 GHz System - 2000
Data Category - Expected Case Summary (Mbps)

	Scenario 1		Scenario 2		Scenario 3	
	Mbps	Percent	Mbps	Percent	Mbps	Percent
Data Transmission Applications (2)	3199	69	2346	66	4598	68
Electronic Mail Applications (8)	702	15	642	19	1310	20
EFTS/POS Applications (2)	297	6	157	4	229	3
Miscellaneous Applications (3)	436	10	385	11	574	9
Total, All Applications (21)	4633	100	3560	100	6710	100



NET ADDRESSABLE 18/30 GHz SATELLITE MARKET
DATA CATEGORY APPLICATIONS
SCENARIO 2

FIGURE VI-8

7.0 CONSOLIDATED RESULTS AND CONCLUSIONS

Tables VI-18 and VI-19 present the net addressable 18/30 GHz satellite market demand for the three scenarios for the three service categories in the years 1990 and 2000. The forecasts are shown in the units of measurement associated with each service category. The data service category is also presented in megabits per second, which allows it to reflect the network size necessary to implement the forecasted traffic. (The voice and video units of measurement reflect network size without the necessity of significant conversion.)

Figure VI-9 shows the consolidated net addressable satellite market demand expressed in equivalent (50 Mbps) transponders. With this chart, the relative demand for each variety of satellite market can be compared. Only C-band and Ku-band demands are displayed for the year 1980 per the requirement of the study statement of work. For the years 1990 and 2000, 18/30 GHz Scenarios 2 and 3 are added. (The Ku-band and the 18/30 GHz Scenario 1 demands are identical.)

The 18/30 GHz Scenario 2 demand is used as a point of departure in the following comparisons. In 1990, Scenario 2 demand is 54% of Ku-band (Scenario 1) demand; 21% of C-band demand; and, not shown, 4.7% of the net long haul demand (which is calculated at 3735 equivalent transponders). Scenario 3 demand is 72% greater than that of Scenario 2. In the year 2000, Scenario 2 demand is 61% of Ku-band demand; 25% of C-band; and, 6.2% of the net long haul demand (9505 equivalent transponders). Scenario 3 total demand is 67% greater than Scenario 2 in the year 2000 - a quantity which is even slightly greater than total Ku-band demand. By making these comparisons, the relative demand of the analog multipoint C-band system versus the digital point-to-point Ku-band and 18/30 GHz systems is revealed. The substantial impact of the 30% price advantage of Scenario 3 over Scenarios 1 and 2 also is effectively displayed.

Tables VI-20 and VI-21 break the consolidated net addressable satellite market demands, expressed in equivalent transponders, into their constituent parts for the years 1990 and 2000. The contributions to total demand for the voice, video and data service categories are 78%, 14% and 8%, respectively, for Scenario 2 in 1990. In the year 2000, the contributions are 76%, 12% and 12% respectively. The larger share attributable to the data service category is a reflection of the relative average annual growth rates of each category for the ten year period: 12.5% for voice, 10.8% for video and 17.8% for data. (The combined AAGR for Scenario 2 is 12.8%.)

The fundamental conclusion which dominates forecasts of all net addressable satellite market demands, including 18/30 GHz systems, is that the voice service category commands the preeminent position. This is in spite of consistently less adaptability to satellite implementation (21% of long haul traffic network requirements in the year 2000 versus 72% and 63% for video and data) and consistently less tolerance to lower satellite service qualities (76% decline in network requirements from C-band to 18/30 GHz system service qualities in 2000 versus 73% and 64% for video and data). The reason is that the voice service category consistently comprises over 90% of the total net long haul traffic in 1980, 1990 and 2000 (91.7%, 91.2% and 92.9%, respectively) and that this preponderance of demand obscures the greater adaptability to and tolerance of advanced satellite transmission exhibited by the video and data service categories.

Table VI-18

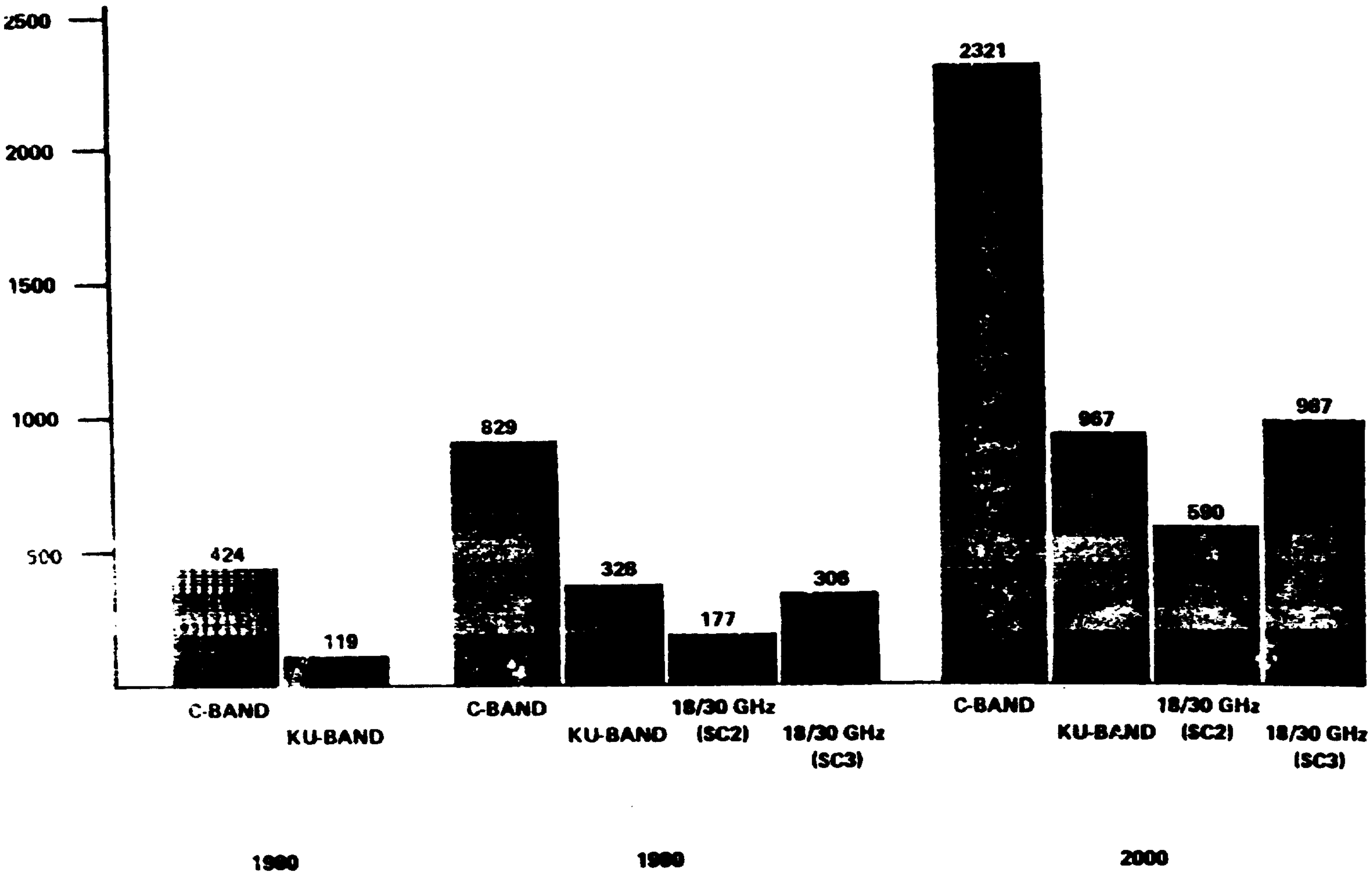
Net Addressable Satellite Market Demand Forecasts Summary

Service Category	Year 1990 Ku-Band & 18/30 GHz (Scenario 1)	18/30 GHz (Scenario 2)	18/30 GHz (Scenario 3)
Voice (Half Circuits x 1000)	372	214	392
Video (Wideband Channels)	93	36	39
Data (Terabits/Year)	2045	1731	3208
Data (Megabits/Second)	(920)	(677)	(1336)

Table VI-19

Net Addressable Satellite Market Demand Forecasts Summary

Service Category	Year 2000 Ku-Band & 18/30 GHz (Scenario 1)	18/30 GHz (Scenario 2)	18/30 GHz (Scenario 3)
Voice (Half Circuits x 1000)	1133	697	1211
Video (Wideband Channels)	214	107	115
Data (Terabits/Year)	8980	7575	13708
Data (Megabits/Second)	(4633)	(3560)	(6710)



NET ADDRESSABLE SATELLITE MARKET

(EQUIVALENT TRANSPONDERS)

FIGURE VI-9

ORIGINAL PAGE IS OF POOR QUALITY

Table VI-20

Net Addressable Satellite Market
(Equivalent Transponders)

Year 1990

Service Category	C-Band	Ku-Band & 18/30 GHz (Scenario 1)	18/30 GHz (Scenario 2)	18/30 GHz (Scenario 3)
Voice	630	239	138	252
Video	157	70	25	27
Data	42	19	14	27
Total	829	328	177	306

Table VI-21

Net Addressable Satellite Market
(Equivalent Transponders)

Year 2000

Service Category	C-Band	Ku-Band & 18/30 GHz (Scenario 1)	18/30 GHz (Scenario 2)	18/30 GHz (Scenario 3)
Voice	1862	727	448	777
Video	258	147	70	75
Data	201	93	72	135
Total	2321	967	590	987

SECTION VII

GENERAL STUDY OBSERVATIONS

The overall market demand for telecommunications services is expected to have a higher growth rate than most American business. The fastest growing communications service category is data, with electronic mail and data transmission applications showing the highest growth rates. Video teleconferencing is also projected to provide a significant portion of the demand for video services by the year 2000.

The analyses of users demand for telecommunications indicated that:

- Users often were not able to identify and define their short and long haul demand by service applications. While this is an important element for a communications manager's planning of telecommunications services and facilities, distance separation of the demand for this study required considerable analysis of user operating characteristics.

- The State and Local government units are departmentalized and lack centralized control over their telecommunications requirements and costs. Therefore, this group will be slower in taking advantage of benefits derived from innovative services introduced in the 1980's and 1990's.

Most users participating in the metropolitan area survey were unable to project their telecommunications requirements, services, or volumes, beyond the mid-1980's. Other indicators had to be used to estimate demand in later periods.

The selection of Phoenix as a representative city was demonstrated to be a valid and appropriate choice for a city of its approximate size. However, it is recognized that no one city can be representative of all cities because of their distinctive sizes, locations and demographics.

The parametric cost model indicates that the improving cost advantages of satellite transmission are dependent on system fill levels achieved and new technologies. As system fill increases, cost advantages for satellites improve, thus increasing system fill further.

The multiplexing approach used in a satellite system affects service cost per circuit. TDMA appears to be an efficient mode with data services while FDM has cost advantages for voice services.

Over the 1980-2000 period an increasing proportion of the total traffic in excess of 40 miles will be suitable for satellite transmission. Significant increases in service penetration by satellite systems are projected to occur for video and data services. Voice traffic will continue to dominate the total addressable satellite market. Specific high penetration of satellite services will include private line voice and video teleconferencing, both of which will be suitable for 18/30 GHZ systems.

Satellite traffic is expanding at a rate which will cause the available C and Ku-band satellite systems capacity to be totally saturated within the next two decades. A hypothetical case is shown in Figure VII-1 and indicates the saturation occurring somewhere in the 1990-1995 time period. However, many factors can impact this saturation point to delay its occurrence.

STUDY RESULT CONSIDERATIONS

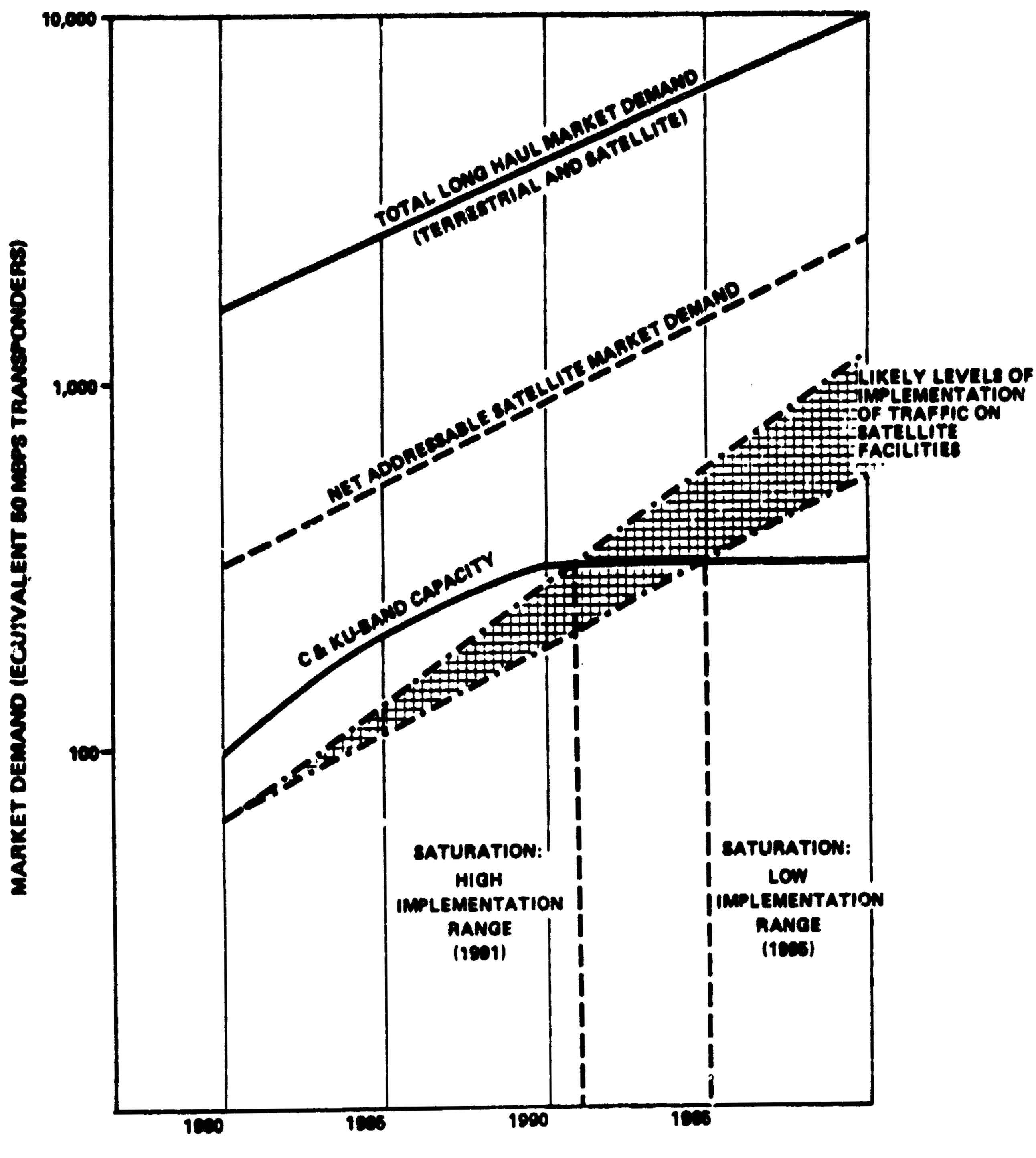
Several areas meriting consideration arose from the final results of this study:

a. The distribution of nationwide traffic varies widely; this indicates a need for a satellite system that provides flexible allocation of bandwidth based on geographical demand rather than a fixed beam capacity.

b. No determination was made in the market study as to the "ideal" or appropriate number of cities to be served via 18/30 GHz system. However, this will be a function of:

   - the available beam coverage, i.e., beam widths
   - bandwidth allocation arrangements
   - heavy route concentrations and configurations
   - types of services to be provided, i.e., voice, video, and data

c. Due to the undeterminability of satellite traffic market shares and the number of carriers vying for that market in the future, all satellite service forecasts have been identified as net addressable market demand. This is defined as demand which could be suitably served by satellite systems in the C, Ku or 18/30 GHz.



C & Ku-BAND SATELLITE SATURATION
ESTIMATED YEARS OF OCCURRENCE

FIGURE VII-1

The limitations imposed by using net addressable market are that:

- there is overlapping demand which exists among all three satellite frequencies, making the forecasts non-additive;
- traffic which is "suitable" is not necessarily the same as traffic actually carried on a specific satellite system;
- the geographic coverage implied in the forecast is for all 275 Standard Metropolitan Statistical Areas (SMSA), which may not be the coverage of an actual system.

d. Due to the limitation discussed in item e., it seems that the potential 18/30 GHz system size requirements only may be determined by examining a number of market scenarios. These scenarios would deal with variations in service price and reliability, common versus trunking networks and most efficient network size.